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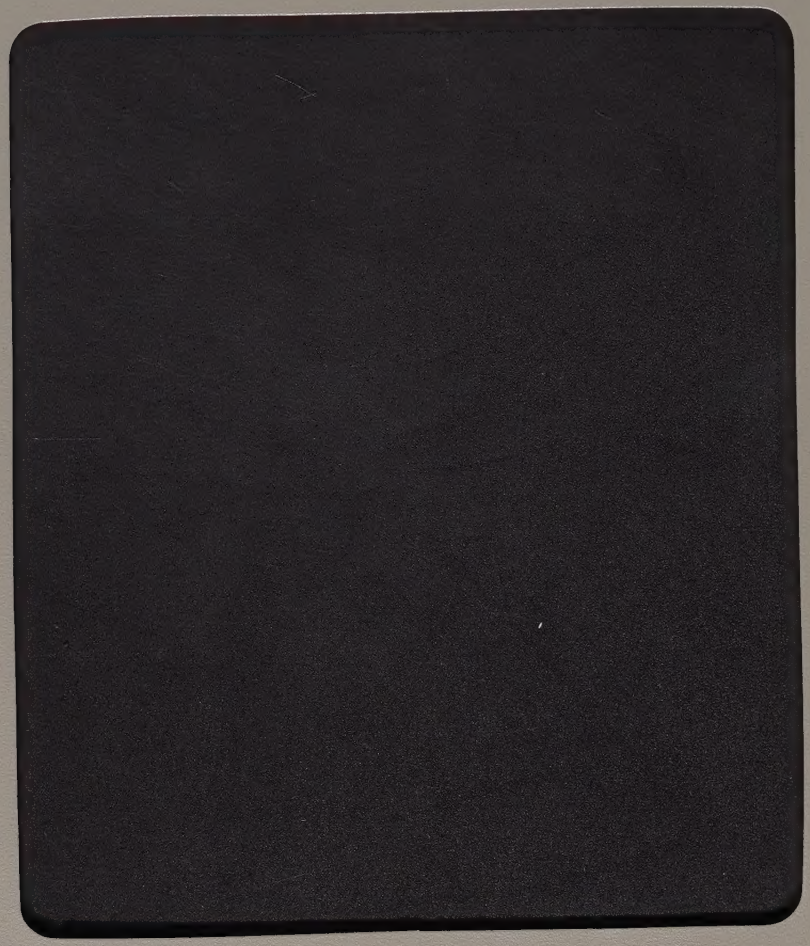

FT-50010

TURBINE ELECTRICAL SYSTEM TEST SET

Service Manual

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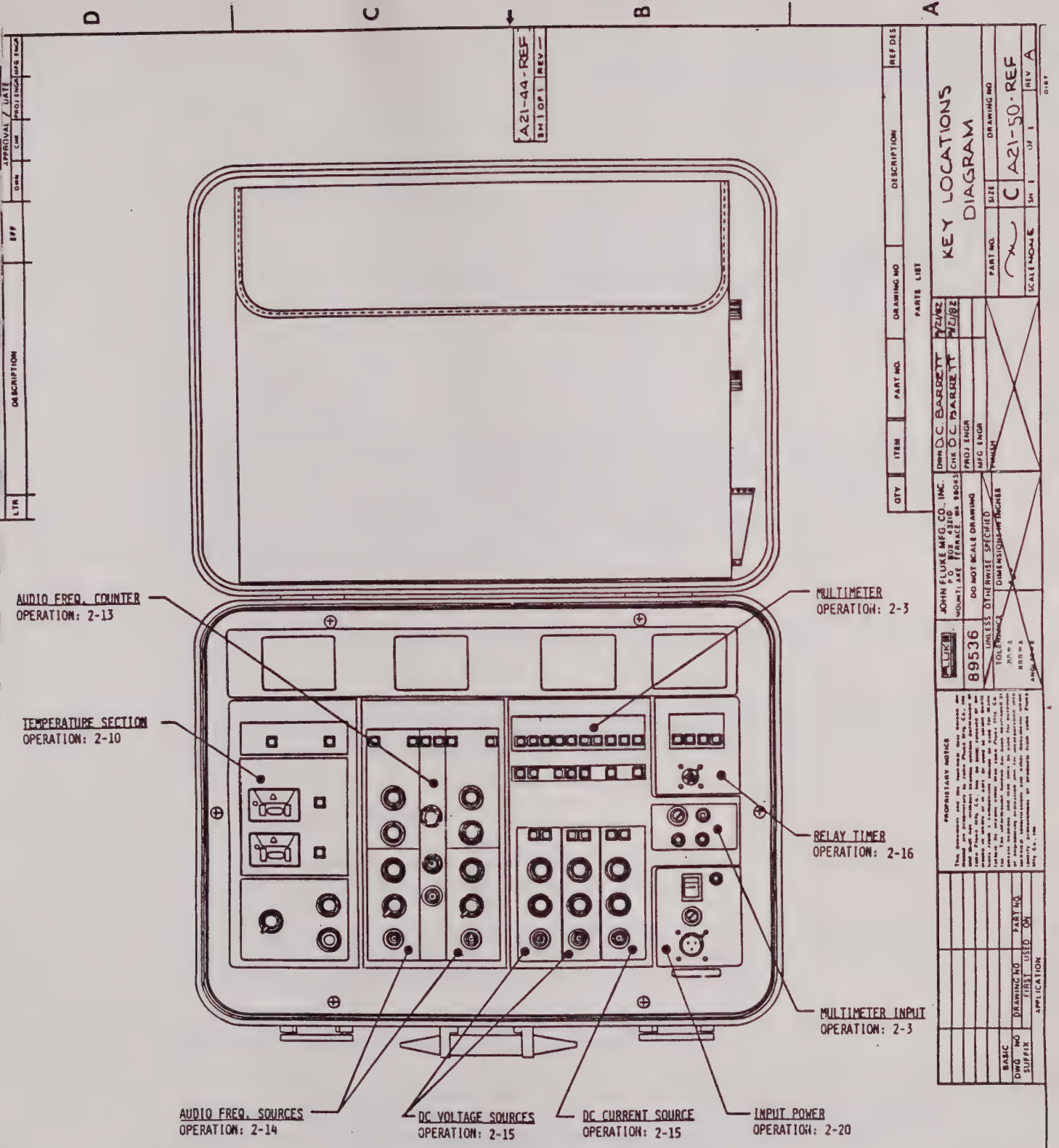


NOTES:

1. INTRODUCTION TO INSTRUMENT: 1-1
2. KEY LOCATIONS REFERENCED BY SECTION/PAGE NUMBER.

SECTION 1
INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The FT-50010 is a portable, integrated test set designed specifically for field testing and trouble shooting of turbine electrical and control systems. It consists of a digital thermometer, a thermocouple indicator calibration source, a digital frequency counter, two audio function generators, two dc voltage sources, a dc current source, a digital multimeter, and a digital time delay relay calibrator. The entire package is housed in a rugged aluminum suitcase and operates from a single dc power source of between 20 and 34 volts.

1-3. All the functions can operate simultaneously without switching hookup leads thus significantly reducing the number of leads necessary and time required to perform maintenance tasks.

1-4. The FT-50010 test set can be used to simulate engine sensory inputs to a turbine control system. The FT-50010 test set then can start, operate, and shut down the control system in a static calibration mode or perform a verification function in an engine operational mode.

1-5. Temperature Section

1-6. The thermometer section of the FT-50010 is a microprocessor based thermocouple indicator capable of precise temperature measurement in either °C or °F.

1-7. Eight switch selectable linearization programs provide a total measurement range of -252°C to 2471°C. Resolution is 0.1° below 2000° and 1° at 2000° and above. (Refer to Table 1-1 for range and accuracy information for each thermocouple type.)

1-8. Electronic cold junction compensation is provided at each of two isolated thermocouple inputs, eliminating the need for external ice point reference baths.

1-9. The thermocouple calibration source simulates any of the eight thermocouple types available on the FT-50010 thermometer section. This section operates together with the thermometer to provide a convenient means of accurately calibrating external indicators.

1-10. Audio Frequency Section

1-11. The frequency counter section accurately measures sine or square wave inputs over a frequency range of 25 Hz to 100 kHz with 1 Hz resolution. This section also features adjustable input sensitivity and automatic frequency overrange indication.

1-12. The two frequency sources are identical and provide sine and square wave functions over a frequency range of 25 Hz to 15 kHz. Output amplitude is adjustable from 0 to 20V rms into a maximum load of 600Ω, with outputs protected against accidental overloads or short circuiting. An adjustable dc offset of 0 to ±18 volts is also provided.

1-13. Multimeter Section

1-14. This section of the FT-50010 is a 3-1/2 digit multimeter capable of measuring dc to 1000 volts and 2000 mA, true rms ac to 750V and 2000 mA, resistance to 20 MΩ, and conductance to 2 mS (millisiemens).

1-15. Multimeter input select switches are also provided allowing the operator to select any of the internal sources, either of two external frequency inputs, or any external voltage, current, or resistance.

1-16. DC Voltage/Current Section

1-17. The two voltage sources are identical and provide 0 to 10V dc on two ranges. Maximum load current is 400 mA, with output protected against accidental overloads or short circuiting. Source impedance to the output connector is less than 0.04Ω.

1-18. The current source provides 0 to 100 mA on two ranges. Maximum compliance voltage is +28V dc.

1-19. Timer Section

1-20. The relay timer section of the FT-50010 permits checkout and accurate setting of all time delay relays, for either solid state or pneumatic delays. Both pick up and drop-out mode timing are provided. The relay timer is capable of measuring relay contact time delays up to 1999.9 seconds.

1-21. Power Supply

1-22. Power input conditioning is provided by a single switching mode preregulator. This section supplies a regulated 12 volts dc to each of four driven inverters. The four inverters provide a total of 8 isolated supplies to the various functional subsections.

1-23. SPECIFICATIONS

1-24. Specifications for the FT-50010 are shown in Table 1-1.

Table 1-1. FT-50010 Specifications

Thermocouple Thermometer

DISPLAY	°F or °C, switch selectable, seven segment liquid crystal
RESOLUTION	0.1° below 2000°F or °C, 1° above 2000°F or °C, autoranging
MEASUREMENT METHOD	Dual slope integration, under microcomputer control. 100 ms integration period, three readings per second
LINEARIZATION TECHNIQUE	Computer algorithm, 4th order curve fit. Eight switch selectable linearizations: J, K, T, E, R, S, B, C

NOTE: "C" is not an ISA/ANSI thermocouple designation. C is used for convenience to represent Tungsten 5% Rhenium versus Tungsten 26% Rhenium alloy.

TEMPERATURE COEFFICIENT	≤15 ppm/°C from 25°C
STABILITY	≤175 ppm in 90 days, 200 ppm/year
MAX. COMMON MODE VOLTAGE	350V dc or 250V ac rms
ZERO DRIFT	None, automatic zero correction
INPUT CONNECTION	2 wire, isolated, on screw terminal isothermal block. Two switch selectable inputs
INPUT IMPEDANCE	100 MΩ at dc
MAX SOURCE IMPEDANCE	2 kΩ
OVERRANGE INDICATION	Positive or negative full scale display (± O.L), depending upon polarity of overrange input
OPEN CIRCUIT DETECTION	A source impedance of 2 kΩ or more causes a display of "0.C"
ACCURACY	See adjacent table "Thermometer Accuracy Specifications"

Table 1-1. FT-50010 Specifications (continued)

THERMOMETR ACCURARY SPECIFICATIONS

MAXIMUM ERROR *

T/C TYPE	APPLICABLE PORTION OF TEMP. RANGE, °C	± DEGREES C AT CAL.	90 DAYS 20°C to 30°C	1 YEAR 15°C to 35°C	Application Portion OF TEMP. RANGE, °F	± DEGREES F AT CAL.	90 DAYS 68°F to 86°F	1 YEAR 59°F to 95°F
J	-128 to 0 0 to 900	0.18 0.18	0.19 0.31	0.21 0.36	-198 to 32 32 to 1652	0.20 0.20	0.20 0.47	0.26 0.58
K	-132 to 0 0 to 1350	0.18 0.18	0.19 0.39	0.21 0.47	-206 to 32 32 to 2462	0.30 0.30	0.33 0.72	0.37 0.87
T	-243 to 0 0 to 400	0.18 0.18	0.20 0.22	0.22 0.25	-405 to 32 32 to 752	0.30 0.30	0.35 0.41	0.39 0.46
E	-252 to 0 0 to 1000	0.18 0.18	0.20 0.33	0.22 0.39	-422 to 32 32 to 1832	0.30 0.30	0.35 0.61	0.40 0.72
R	0 to 1708	0.31	0.59	0.70	32 to 3106	0.47	1.01	1.20
S	0 to 1685	0.22	0.50	0.60	32 to 3065	0.38	0.92	1.10
B	420 to 1815	0.21	0.52	0.62	788 to 3364	0.37	0.95	1.15
C	0 to 2471	0.18	0.60	0.75	32 to 4480	0.30	1.11	1.37

* FOR READINGS ABOVE 1999.9 DEGREE C OR DEGREE F ADD ± .5 DEGREES ROUND OFF ERROR
ACCURACY STATEMENT DOES NOT INCLUDE THERMOCOUPLE ERRORS
TABLE 1-1

Table 1-1. FT-50010 Specifications (continued)

Thermocouple Calibrator

COMPATIBLE THERMOCOUPLE TYPES.....	J, K, T, E, R, S, B, C
OUTPUT IMPEDANCE.....	100Ω
RANGE.....	-10 to +90 mV dc, 25°C
TEMPERATURE COEFFICIENT.....	≤ 20 ppm/°C from 25°C

Audio Frequency Counter

MEASUREMENT RANGE.....	25 Hz to 100 kHz
DISPLAY.....	5-digit liquid crystal with 'Hz'
ACCURACY.....	±(0.01% + 1 count) 0 - 50°C
TIMEBASE STABILITY.....	≤ 10 ppm/year
GATE TIME.....	1 second
DISPLAY UPDATE TIME.....	1.2 second
SENSITIVITY.....	Adjustable 75 mV rms to full scale, over 25 Hz to 100 kHz
MAXIMUM INPUT WITHOUT DAMAGE....	500V dc or peak ac
INPUT IMPEDANCE.....	10 MΩ for inputs -1 to +1 volt 100 kΩ for inputs above ±1 volt
OVERFLOW.....	Display reads 0.0.0.0.0

Audio Frequency Sources

FUNCTION.....	Sine, Square; switch selectable
FREQUENCY RANGE.....	25 Hz to 15 kHz
FREQUENCY TEMP COEF.....	≤ 0.5%/°C
AMPLITUDE.....	0 to 20V rms into 600Ω
DISTORTION (SINE WAVE).....	5% from 1 kHz to 10 kHz
OUTPUT IMPEDANCE.....	Less than 1Ω
DC OFFSET.....	-18V to +18V variable

Table 1-1. FT-50010 Specifications (continued)

Multimeter

DISPLAY..... 3-1/2 digit liquid crystal, auto polarity and decimal point

DC VOLTS (Multimeter)

Accuracy, 1 Year..... ±(0.1% of reading + 1 digit)

Input Impedance..... 10 MΩ

Overvoltage Protection..... 1000V dc or peak ac

Response Time..... 1 second

AC VOLTS (Multimeter)

Accuracy, 1 Year..... see table below

Crest Factor Range..... 1.0 to 3.0

Input Impedance..... 10 MΩ/100 pf

Overload Protection..... 750V rms or 1000V peak

Not to exceed the volt-hertz product of 10^7 (except for 10 seconds maximum on 200 mV & 2V range)

Response Time..... 2 seconds maximum within a range

AC Voltage Accuracy

<table>
<tr><th>RANGE</th><th>45 Hz TO 1 kHz</th><th>1 kHz to 10 kHz</th><th>10 kHz to 20 kHz</th></tr>
<tr><td>200 mV</td><td rowspan="4" colspan="2">±(0.8% of READING + 2 DIGITS)</td><td rowspan="3">±(1% of READING + 2 DIGITS)</td></tr>
<tr><td>2V</td></tr>
<tr><td>20V</td></tr>
<tr><td>200V</td></tr>
<tr><td>750V</td><td colspan="2">NOT RATED</td></tr>
</table>

Table 1-1. FT-50010 Specifications (continued)

DC CURRENT (Multimeter)

Accuracy..... ±(0.3% of reading + 1 digit)

Burden Voltage..... 0.3V max, 200 µA thru 200 mA ranges; 1.5V max, 2000 mA range

Overload Protection..... 2A/250V external fuse in series with an internal 3A/600V fuse

AC CURRENT (Multimeter)

Accuracy, 1 Year..... see table below

Burden Voltage..... 0.3V max, 200 µA to 200 mA ranges; 1.5V max, 2000 mA range

Overload Protection..... 2A/250V external fuse in series with an internal 3A/600V fuse

Crest Factor Range..... 1.0 to 3.0

Response Time..... 2 seconds maximum within a range

AC Current Accuracy

<table>
<tr><th>RANGE</th><th>45 Hz to 2 kHz</th><th>2 kHz to 10 kHz</th><th>10 kHz to 20 kHz</th></tr>
<tr><td>200 µA</td><td rowspan="4">±(1% of READING + 2 DIGITS)</td><td rowspan="4"></td><td rowspan="4">±(2% of READING + 2 DIGITS)</td></tr>
<tr><td>2 mA</td></tr>
<tr><td>20 mA</td></tr>
<tr><td>200 mA</td></tr>
<tr><td>2000 mA</td><td colspan="2">NOT RATED</td></tr>
</table>

Table 1-1. FT-50010 Specifications (continued)

RESISTANCE (Multimeter)

Accuracy, 1 Year..... see table below

Overload Protection..... 300V dc/ac rms, all ranges

Open Circuit Voltage..... less than 3.5V, all ranges

Response Time..... 1 second, 200Ω thru 20 kΩ ranges
4 seconds, 200 kΩ and 20 MΩ ranges

Resistance Accuracy

RANGE	ACCURACY	FULL SCALE VOLTAGE	MAX TEST CURRENT
200Ω*	±(0.2% of READING + 1 DIGIT)	0.025V	1.3 mA
2 kΩ		1.0V	1.3 mA
20 kΩ		< 0.25V	10 µA
200 kΩ		1.0V	35 µA
2000kΩ	±(0.5% of READING + 1 DIGIT)	< 0.25V	0.10 µA
20 MΩ		1.5V	0.35 µA

*For specified accuracy in the 200Ω range, any residual resistance must be zeroed: record the measurement, then subtract from that the reading obtained with the input leads shorted together.

Table 1-1. FT-50010 Specifications (continued)

CONDUCTANCE (Multimeter)

Accuracy, 1 Year..... see table below

Overload Protection..... 300V dc/ac rms on all ranges

Conductance Accuracy

RANGE	ACCURACY	FULL SCALE VOLTAGE	MAX TEXT CURRENT
2 mS	±(0.2% of READING + 1 DIGIT)	3.5V	1.3 mA
20 µS		1V	10.0 µA
200 nS	±(1% of READING + 10 DIGITS)	1V	0.10 µA

DC Voltage Sources

OUTPUT..... 2 Ranges; 0 to 1V, 0 to 10V

OUTPUT IMPEDANCE..... < 0.040Ω to the output connector

TEMPERATURE COEFFICIENT..... ≤ (20 µV + 250 ppm)/°C

MAX. LOAD CURRENT..... 400 mA

OUTPUT PROTECTION..... Protected against continuous short circuit

CURRENT LIMIT POINT..... ~ 600 mA

DC Current Source

OUTPUT..... 2 Ranges; 0 to 1000 µA, 0 to 100 mA

TEMPERATURE COEFFICIENT..... ≤ 200 ppm/°C

COMPLIANCE VOLTAGE..... +28V max

Table 1-1. FT-50010 Specifications (continued)

Relay Timer

RANGE	1999.9 seconds
MODES	Delay pick up, delay drop out
DISPLAY	4-1/2 digit liquid crystal with decimal point
ACCURACY	±0.01% + 1 count, 0 to 50°C
TEMPERATURE COEFFICIENT	≤ 0.1 ppm/°C
TIMEBASE STABILITY	≤ 10 ppm/year
OVERFLOW	Display reads 0.0.0.0.0

General Specifications

POWER	20 to 34V dc, 3A max
WARM UP TIME	5 minutes
DIMENSIONS	15.4 cm H x 33.0 cm W x 45.7 cm L (6.08" H x 13" W x 18" L)
WEIGHT	Approximately 8.6 kg, (19 lbs)

Environmental

STORAGE TEMPERATURE	-40°C to 75°C
OPERATING TEMPERATURE	0 to 50°C
RELATIVE HUMIDITY	0 to 80% up to 50°C (non-condensing)
SHOCK AND VIBRATION	Meets MIL-T-2800 Specifications

SECTION 2
OPERATING INSTRUCTIONS

2-1. INTRODUCTION

2-2. The FT-50010 operator panel is arranged into the functional subsections: multimeter, thermometer, audio frequency sources, dc voltage sources, dc current source, and relay timer. Four displays allow for simultaneous measurement of thermometer, frequency counter, multimeter, and relay timer. Adjustments or measurements made on one section will have no effect on any of the other sections.

2-3. The following paragraphs describe operation of each of these sections. The multimeter is covered first as this section is used to monitor most of the other sections.

> NOTE: Instructions for making power input connections are covered in paragraphs at the end of Section 2, under Making Power Connections.

2-4. There are five triangular shaped caution ⚠ symbols located on the instrument front panel. One on each of the two thermocouple input assemblies, one next to the T/C signal select pushbutton, one next to the external frequency input jacks, and one on the multimeter input jacks. Please refer to the four cautions in later sections of this manual marked by these same symbols.

WARNING

DO NOT TOUCH TERMINALS WHEN HIGH VOLTAGES ARE PRESENT. ALL SECTIONS OF THE FT-50010 AND ASSOCIATED INPUTS AND OUTPUTS ARE ELECTRICALLY ISOLATED FROM EACH OTHER. UP TO 350V DC OR PEAK AC MAY BE PRESENT BETWEEN TERMINALS IN DIFFERENT SECTIONS OR BETWEEN ANY TERMINAL AND THE INSTRUMENT CASE.

2-5. SHIPPING INFORMATION

2-6. The FT-50010 Test Set is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included in the shipping carton.

2-7. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument's model number when requesting a new shipping container.

2-8. OPERATING NOTES

2-9. Multimeter Section

2-10. MULTIMETER DISPLAY

2-11. The multimeter display is a 3-1/2 digit LCD providing 1,999 counts of resolution. A decimal point, polarity indicator, and overrange indicator are also included. Decimal point positioning is automatic and is determined by the selected measurement range.

2-12. Polarity sensing is also automatic, and is valid for dc voltage and current measurements. A minus sign indicates that the input voltage or current is negative with respect to multimeter input common. Voltage or current inputs that are positive with respect to common are indicated by the absence of a minus sign.

> NOTE: Two other conditions may cause the negative sign to be displayed, neither of which indicates a valid display. Please refer to paragraphs 2-13 (Overrange) and 2-43 (Resistance).

2-13. OVERRANGE

2-14. An overrange condition is indicated by a "1" followed by three blank digits. (A decimal point may also be present, depending upon the range selected.) An overrange display indicates that the unknown input (voltage, current, resistance, or conductance) is of sufficient amplitude to require that a higher range be selected, and does not necessarily mean that the input will damage the instrument. (Refer to multimeter specifications, Table 1-1, for dc volts or ac volts overvoltage limits.)

2-15. When measuring resistance, the overrange indication is displayed to indicate an open input condition or an input resistance greater than the selected range can measure.

> NOTE: When the instrument comes out of an overrange condition the minus sign may flash momentarily (most likely seen when measuring resistance).

2-16. MEASUREMENT UNITS

2-17. There are no measurement unit indicators on the multimeter display. To determine units of measure note the selected function and range. For example if the volt (V) function is selected, and the 200 mV range is selected, and the unknown input is within the selected range; the display will represent a voltage of between 000.0 and ±199.9 mV.

2-18. FUNCTION SWITCHES

2-19. The first four pushbutton switches on the left, directly below the multimeter display, are used to select the desired measurement function.

2-20. The leftmost switch, marked AC/DC, is used in conjunction with the "V" and "mA" switches to determine the type of voltage or current to be measured. If the AC/DC switch is in the OUT position the multimeter is configured for DC voltage or current measurement. If the switch is depressed, only the AC components of the input signal will be measured.

2-21. The V, mA, and kΩ/S switches select the voltage, current or resistance/conductance functions. These three pushbuttons are interlocked. Depressing one pushbutton will cause either of the other two to return to the out position.

2-22. RANGE SWITCHES

2-23. The next six pushbuttons are used to select the desired measurement range. They provide 5 ranges of AC/DC voltage and current, 6 ranges of resistance, and three ranges of conductance. They are also interlocked. As indicated on the operator panel, any one of the three conductance ranges may be selected by depressing the two appropriate pushbuttons simultaneously.

2-24. MULTIMETER INPUT SELECT SWITCHES

2-25. The EXT/INT pushbutton is used to connect either the multimeter external input terminals or the internal select switches to the multimeter input. The EXT/INT pushbutton must be in the OUT position to connect the FREQ, EXT FREQ, DC VOLTS OUT, or DC mA OUT to the multimeter.

2-26. Directly below the function and range switches there is a group of seven pushbutton switches. These switches are used to select the desired input to the multimeter.

2-27. The pushbuttons marked FREQ 1 and 2 connect the outputs of the internal frequency sources to the multimeter input. Both waveform amplitude and dc offset level can be measured by proper multimeter function selection.

2-28. The EXT FREQ pushbutton is used to connect the selected external frequency input to the multimeter input.

2-29. The DC VOLTS OUT 1 and 2 pushbuttons are used to connect either one of the two internal dc voltage source outputs to the multimeter input.

> NOTE: The regulation specifications given in Section 1 for the DC Voltage Sources apply to voltage levels present at the output terminals, which is where multimeter measurements are made. If greater measurement accuracy is required (as may be the case if output current is near the maximum specified and the test leads to the load are long) it is suggested that the voltage measurements be made at the load using the multimeter external input.

2-30. The DC mA OUT pushbutton is used to connect the output of the current source to the multimeter mA input. When this switch is depressed the multimeter is placed in series with the internal compliance voltage source and the current source output high terminal. If DC mA OUT is NOT selected the internal compliance voltage source is connected directly to the current source output high terminal.

NOTE: In order for current to flow, a load must be placed between the current source HI and LO output terminals.

2-31. The EXT/INT pushbutton is used to connect either the multimeter external input terminals or the internal select switches to the multimeter input. With the EXT/INT pushbutton pushed in the multimeter may be used to measure any external voltage, current, or resistance source that does not exceed specified input limits.

2-32. MULTIMETER EXTERNAL INPUT

2-33. This section consists of three banana/binding post connectors and a fuse. Voltage, resistance, and conductance inputs are connected between the V/kΩ/S and common terminals. Current inputs are connected between the mA and common terminals. The fuse is to protect the current input circuitry from damage if a current input of greater than 2A is applied.

2-34. VOLTAGE MEASUREMENTS

2-35. To make voltage measurements, use the following procedure:

CAUTION

THE VOLTAGE SOURCE SHOULD NOT EXCEED 1000V DC OR 750V RMS AC OR DAMAGE TO THE INSTRUMENT MAY RESULT.

1. Select the AC or DC volts function.
2. Select the desired measurement range.
3. Select the desired voltage source (any of the internal sources, or the external binding posts).
4. The unknown voltage should now be displayed.

2-36. Under most measurement conditions, source loading errors should not be a problem. If source impedance is 10 kΩ or less, the error will be less than 0.1%. Loading error can be calculated using the formulas listed below.

1. For DC voltage measurements:

$$\text{Error in \%} = 100 \times R_S \pm (R_S + 10^7)$$

Where: R_S = source resistance in ohms (Ω)

2. For AC voltage measurements:

$$\text{Error in \%} = \frac{100 \times Z_S}{R_S + Z_{IN}}$$

Where: R_S = Source Resistance
Z_S = Source Impedance
Z_{IN} = Effective Input Impedance; where:

$$Z_{IN} = \frac{10^7}{\sqrt{1 + (2 \times \pi \times F \times R_{IN} \times C)^2}}$$

Where: $R_{IN} = 10^7\Omega$
$C = 100 \times 10^{-12}F$
$F = Hz$
$\pi = 3.14159$

2-37. Composite AC/DC waveforms can also be measured. Measure the ac component of the waveform using the AC function of the multimeter. Measure the dc component using the DC function. The total rms value of the waveform is:

$$\text{RMS Total} = \sqrt{(\text{AC Component})^2 + (\text{DC Component})^2}$$

2-38. CURRENT MEASUREMENTS

2-39. To make current measurements, use the following procedure:

CAUTION

INPUT CURRENT SHOULD NOT EXCEED 2A. OPEN CIRCUIT VOLTAGE SHOULD NOT EXCEED 250V DC or 250V PEAK AC.

1. Select AC or DC current function.
2. Select desired measurement range.
3. Connect the multimeter into the circuit to be tested. The unknown current should now be displayed.

2-40. If the current source being measured is unregulated, or if the resistance of the multimeter current shunt and fuse represents a significant part (1/1000 or more) of the source resistance, then burden voltage errors may need to be considered. Burden voltage is the voltage drop at the multimeter's terminals when measuring current (that voltage across the multimeter's current shunt and protective fuses).

2-41. Burden voltage error can be calculated using the following formulas:

$$E_B = \frac{100 \times \text{Reading} \times E_{B_{(\text{Full Scale})}}}{\text{Full Scale}}$$

Where: Reading = Displayed Current Reading
E_B = Burden voltage (calculated)
Full Scale = Range Selected
$E_{B_{(\text{Full Scale})}}$ = Specified full scale burden voltage for range selected (Refer to multimeter DC or AC Current specifications for this value).

$$\% \text{ error} = 100 \times \frac{E_B}{E_S - E_B}$$

Where: E_B = Burden Voltage (Calculated)
E_S = Source Voltage

$$\text{Error in amps} = \frac{E_B}{E_S - E_B} \times I_M$$

Where: E_B = Burden voltage (calculated)
E_S = Source voltage
I_M = Measured current in amps

2-42. An example of burden voltage calculations follows. Assume these conditions are given: $E_S = 14V$, $R_L = 9\Omega$, $I_M = 1.497A$, $E_{B_{(full\ scale)}}$ (from specification table) = 1.5V

1. $$E_B = \frac{1.497A}{2.000A} \times 1.5V$$

$$= 74.85\% \text{ of } 1.5V$$

$$= 1.123V$$

2. $$\% \text{ Error} = 100 \times \frac{1.123}{14 - 1.123}$$

$$= 8.721\%$$

3. $$\text{Error in amps} = \frac{1.123}{14 - 1.123} \times 1.497$$

$$= 0.131A$$

Displayed Current = 1.497A
Actual Current = 1.628A

2-43. RESISTANCE MEASUREMENTS

2-44. To make resistance measurements, use the following procedure:

1. Select the Resistance function.
2. Select the desired measurement range. The multimeter should display an open circuit condition ("1" followed by three blank digits), with no load connected.
3. Connect the unknown resistance to the multimeter external input.
4. The unknown resistance should be displayed.

2-45. When using the 200Ω range, more accurate measurements can be made if lead resistance is considered. Short the sampling ends of the test leads together and read the lead resistance and subtract this lead resistance from your measurements.

2-46. The 2 kΩ resistance range has a diode symbol beside the range value and has a high enough open circuit voltage to turn on silicon junctions. This range can be used to check silicon diodes and transistors. In circuit resistance measurements should be made with ranges other than the 2kΩ range since they cannot turn on silicon junctions and will give more accurate in circuit measurements when active components are present.

2-47. If you are reading resistance and the minus sign remains on, there is still energy in the circuit under test. The circuitry may still have power applied or a capacitor may still be charged. Reversing the test leads will result in erroneous readings. If there is any doubt about the circuit under test, read the resistance, then reverse the test leads. If a minus sign is displayed in either case, the circuit must be de-energized before accurate resistance measurements can be made.

2-48. CONDUCTANCE MEASUREMENTS

2-49. Conductance is the inverse of resistance and can therefore be computed using the formula:

$$S = 1/R.$$

Where: R = Resistance in Ω (ohms)
S = Conductance in S (siemens)

2-50. The three conductance ranges span resistance measurements of 500Ω to 10,000MΩ. These ranges allow noise free measurements of inverse function components (such as photo diodes, high value resistors, diode and capacitor leakage characteristics, or transistor beta). Make conductance measurements as follows:

1. Select the kΩ/S function.
2. Select the desired range by depressing the two appropriate pushbuttons simultaneously.
3. Connect the unknown resistance to the multimeter external input terminals.
4. The unknown resistance should be displayed in terms of siemens.
5. To convert the measurement to ohms, divide the reading into 1.

For example: $\frac{1}{1\mu S} = \frac{1}{1\times10^{-6}S} = 1\times10^{6}$ ohms = 1 MΩ

2-51. Thermometer

2-52. TEMPERATURE DISPLAY

2-53. The thermometer display is a 4-1/2 digit LCD providing 0.1° resolution below 2000°C or °F, and 1° resolution from 2000°C or °F and above. The selected temperature scale (either °C or °F) is indicated to the right of the temperature display. A decimal point, polarity indication, overrange indication, and open circuit indication are also provided.

2-54. OVERRANGE

2-55. Overrange is indicated by either -0.L or 0.L, depending upon input polarity. An overrange display indicates that the unknown temperature input is of an amplitude greater than the selected thermocouple range. It does not necessarily mean that the input will damage the instrument. (Refer to Table 1-1 for overvoltage specifications.)

2-56. OPEN CIRCUIT DETECTION

2-57. A source impedance of 2 kΩ or greater will cause the thermometer to display 0.C. This informs the operator of a faulty thermocouple or poor input connection.

2-58. TEMPERATURE SCALE SELECTION

2-59. The thermometer will display temperature in either degrees Celsius or degrees Fahrenheit. Scale selection is made using the °F/°C switch located to the far left, below the temperature display. Scale changes can be made at any time, and have no effect on the calibration of the instrument.

2-60. THERMOCOUPLE SELECTION

2-61. The measurement range of the thermometer is determined by the type of thermocouple used as the input device. Any one of eight thermocouple ranges may be selected using the rotary SELECT TYPE T/C switch located below the input modules. Refer to Table 1-1 for thermocouple range information.

> NOTE: It is important that the selected range match the type of thermocouple used. Otherwise, all temperature readings will be erroneous.

2-62. THERMOCOUPLE INPUT SELECT

2-63. There are two thermocouple input modules installed in access ports in the thermometer section. The two modules are identical and each provides one set of screw-type input terminals. This allows switch selectable measurement of two temperature sources, by using the two switches located to the right of the input modules.

2-64. Two thermocouple types may also be used. This, however, requires that the operator reselect thermocouple type as well as the thermocouple input module.

> NOTE: The thermocouple input modules have been calibrated to match the specific tester in which they are installed. Measurement errors will result if they are used in another tester without recalibration.

2-65. THERMOCOUPLE SIGNAL SELECT

2-66. Depress the Thermocouple Signal Select pushbutton to enable the CALIBRATION OUTPUT. This connects the output of the internal calibration source to the input terminals of the thermometer. The calibration voltage therefore appears at the screw terminals on the thermocouple input module selected. When measuring temperature, the T/C Signal Select switch should be in the EXTERNAL INPUT (OUT) position. (Refer to a section which follows for detailed instructions on calibrator operation.)

2-67. TEMPERATURE MEASUREMENT

2-68. To make temperature measurements, use the following procedure:

1. Remove one or both of the T/C input modules.
2. Connect the selected thermocouple(s) to the screw terminal(s) on the input modules.
3. Connect the input modules to the mainframe through the access ports.
4. Set the T/C type select switch to match the thermocouple selected.
5. Select the desired temperature scale using the °F/°C select switch.

CAUTION

⚠ **THE MAXIMUM VOLTAGE THAT MAY BE CONNECTED BETWEEN ANY TWO THERMOCOUPLE INPUT TERMINALS IS 350V DC OR 250V RMS AC. GREATER VOLTAGE MAY RESULT IN DAMAGE TO THE INSTRUMENT.**

6. Expose the thermocouple probe to the unknown temperature to be monitored, within the thermocouple's specified range.
7. The probe temperature will be displayed (in °F or °C).

2-69. Thermocouple Calibrator

2-70. The calibrator section provides thermocouple simulation outputs of between -10 mV and +90 mV. It is used for calibration of external thermocouple indicators. Connect and operate the calibrator as follows:

1. Remove one of the T/C input modules.
2. Connect a length of the desired thermocouple wire between the T/C input module and the external indicator to be tested. Observe proper polarity.
3. Install the T/C input module in the FT-50010 test set.
4. Select the proper T/C Type on the thermometer.
5. Select the thermocouple input (T/C 1 OR T/C 2) that is connected to the external indicator.

CAUTION

TO PREVENT DAMAGE TO THE INTERNAL CALIBRATOR DO NOT CONNECT HIGH VOLTAGES (GREATER THAN 10 VOLTS) TO ANY OF THE T/C INPUT TERMINALS WHILE THE T/C SIGNAL SELECT PUSHBUTTON IS IN THE CALIBRATION OUTPUT (DEPRESSED) POSITION.

6. Press the T/C SIGNAL select pushbutton to the CALIBRATION OUTPUT (depressed) position.
7. Select the desired temperature scale.
8. Using the COARSE and FINE adjustments in the CAL/OUTPUT section, adjust the calibrator output for the desired temperature display.
9. Adjust the external indicator so that its reading agrees with the FT-50010 thermometer display.

2-71. Audio Frequency Counter

2-72. FREQUENCY COUNTER DISPLAY

2-73. The frequency counter display is a 5 digit LCD providing 100,000 counts of resolution. A measurement units indicator (Hz), and overflow indication are also provided.

2-74. OVERFLOW

2-75. A frequency of 100,000 Hz or greater will cause the display to indicate an overflow condition. This display will be five 0's and four decimal points (0.0.0.0.0 Hz).

2-76. COUNTER INPUT SELECT

2-77. There are four interlocked counter input select switches located directly below the counter display. These switches are used to connect the desired frequency source to the input of the frequency counter. The operator can choose between the two internal frequency sources or two external frequency inputs.

2-78. TRIGGER LEVEL

2-79. A one turn pot is provided to allow the trigger level of the selected external frequency input to be adjusted. When the pot is in the full counter clockwise position (MIN) the counter will trigger at any signal greater than 75 mV rms. Turning the pot clockwise increases the trigger level. This allows the user to adjust the trigger level to prevent counting noise on the input signal.

2-80. FREQUENCY MEASUREMENT

2-81. To make frequency measurements, use the following procedure:

CAUTION

INPUT SIGNAL AMPLITUDE SHOULD NOT EXCEED 500V AC PEAK OR 500V DC. ANY AC SIGNALS OF GREATER THAN 100V PEAK SHOULD NOT BE APPLIED FOR LONGER THAN FIVE MINUTES, OR DAMAGE TO THE INSTRUMENT MAY RESULT.

1. Connect the desired frequency source to the frequency counter using the counter input select switches.

2. The unknown frequency will be displayed.

3. The amplitude of the selected frequency source may be measured by selecting the proper multimeter input and range.

2-82. Audio Frequency Sources

NOTE: The following instructions apply to both frequency sources.

2-83. FUNCTION SELECT

2-84. The sine and square wave output functions are selected using a push-push switch located in the upper corners of the audio frequency section.

2-85. FREQUENCY ADJUST

2-86. The output frequency is continuously variable from 25 Hz to 15 kHz. One 10-turn coarse and one 10-turn fine adjustment control are provided for this purpose. Clockwise rotation of either control will increase output frequency.

2-87. AMPLITUDE ADJUST

2-88. A single 10-turn control is used for output amplitude adjustment. Clockwise rotation of the control will increase the output amplitude. Adjustment range is from 0 to 20V rms.

2-89. DC OFFSET

2-90. The output waveform may be superimposed on an adjustable dc offset. The offset is continuously variable between -18V dc and +18V dc.

2-91. The offset control, located directly above the output connector, is a combination push/pull switch and 1-turn potentiometer. Pushing the switch in disables the offset (0V dc offset). When the switch is pulled out, rotating the offset control in a clockwise or counterclockwise direction will make the DC offset more positive or more negative, respectively.

2-92. DC Voltage Sources

NOTE: The following instructions apply to both dc voltage sources.

2-93. RANGE SWITCHES

2-94. Two interlocked pushbutton switches are used to select either of two voltage output ranges. On the lower range, output level is continuously adjustable from 0 to 1V. The upper range provides a maximum output of 10V.

2-95. OUTPUT ADJUSTMENT

2-96. Output level is adjusted using a 10-turn coarse control and a 10-turn fine control. Clockwise rotation of these controls increases output level.

2-97. DC Current Source

2-98. Range switching is provided by two interlocked pushbutton switches. On the lower range, output current is continuously adjustable from about 1 μA to 1 mA. The upper range provides a maximum output of 100 mA.

NOTE: There will be no output current flow unless a load is placed across the output terminals. To obtain a full 100 mA output, load resistance should not exceed 280Ω.

2-99. Output current is adjusted using a 10-turn coarse control and a 10-turn fine control. Clockwise rotation of the controls increases output current.

2-100. Relay Timer

2-101. RELAY TIMER DISPLAY

2-102. The relay timer display is a 4-1/2 digit LCD with 19,999 counts of resolution and decimal point and overflow indication.

2-103. OVERFLOW

2-104. The relay timer is capable of measuring delay times up to 1999.9 seconds (approx 33 min). If that limit is exceeded the display will indicate a timer overflow condition by displaying five "0" and four decimal points (0.0.0.0.0).

2-105. CONNECTOR

2-106. Pins A (+24V) and D (ground 1) are the outputs which supply 24V dc to the relay coil. In Delay PICKUP mode, the timer starts counting when this voltage is applied, energizing the coil. In Delay DROPOUT mode, the timer starts counting when this voltage is removed, de-energizing the coil.

2-107. Pins B (sense line) and C (+24V) are inputs which sense the relay contact closure (for PICKUP) or opening (for DROPOUT).

2-108. TIMER CONTROLS

1. DELAY PICKUP -- (Interlocked with Delay DROPOUT) This mode is for measuring the delay time of a delay pickup relay; that is, the time between the coil being energized and the resulting contact closure. Delay pickup relays are designed with a delay of a few seconds up to minutes.

2. DELAY DROPOUT -- Analogous to delay pickup, this mode is for measuring the delay time of a delay dropout relay; that is, the time between the coil being de-energized and the resulting contact opening.

3. ARM -- The ARM pushbutton is depressed to ready the relay for timing which begins when the START button is depressed. When DELAY PICKUP is selected, no voltage is applied to the relay coil when ARM is selected. However, when DELAY DROPOUT is selected, the coil is energized with +24V (Pins "A" to "D" of the relay timer connector) from the front panel.

4. START -- The START pushbutton starts the timer to count and either energizes the relay coil (in DELAY PICKUP) or de-energizes the relay coil (in DELAY DROPOUT).

2-109. MAKING CONNECTIONS TO THE TIMER

2-110. The relay timer section can be used for both solid state and pneumatic delay relays. All pneumatic types and solid state delay pickup type relays should be connected as shown in Figure 2-1. Solid state delay dropout relays should be connected as shown in Figure 2-2.

CAUTION

THE INSTRUMENT POWER (+24VDC) IS CONNECTED THROUGH THE ARM AND START SWITCHES TO BOTH PIN "A" AND PIN "C" OF THE TIMER CONNECTOR. WHEN MAKING CONNECTIONS TO THE TIMER, BE SURE THAT THE TIMER ARM SWITCH IS IN THE OUT (RESET) POSITION, TO NOT ACCIDENTALLY SHORT THE SUPPLY. ON SERIAL NUMBER 4850001 AND GREATER, AN INTERNAL 1A FAST-BLOW FUSE (F301) HELPS TO PROTECT THE TIMER SECTION.

CAUTION

IF SOLID STATE RELAYS ARE USED, MAKE SURE PIN "A" IS CONNECTED TO THE +24 VOLT SIDE OF THE RELAY/CONTROL INPUT, OR DAMAGE TO THE RELAY MAY RESULT.

2-111. Figure 2-1 shows the relay timer connector located on the front panel, viewed from the front. Pins "A" and "D" of the connector should be connected across the relay coil/or control input. Pins "B" and "C" should be connected across the relay contacts.

2-112. MAKING DELAY PICK-UP MEASUREMENTS

1. Make the timer connections to the relay as in the previous paragraphs and figures.

2. Depress the DELAY PICK UP pushbutton to the IN position.

3. Depress the ARM pushbutton to the IN position.

4. Depress the START pushbutton. The timing operation will now begin and the elapsed time will be displayed. Relay contact closure will cause the timer to halt. The elapsed time will be held in the display.

NOTE: Be sure to record the timing results before switching any of the timer control switches.

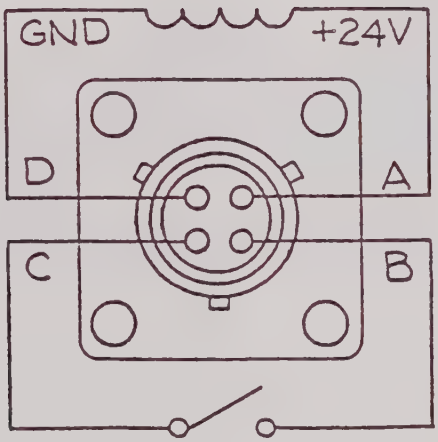


Figure 2-1. Relay timer connections for pneumatic relays (both pickup and dropout), and solid state delay (pickup only) types.

2-113. MAKING DELAY DROPOUT MEASUREMENTS

1. Make the timer connections to the relay as outlined in the previous paragraphs and figures on Making Connections to the Timer.

2. Depress the DELAY DROP OUT pushbutton to the IN position.

3. Depress the ARM pushbutton to the IN position.

4. Depress the START pushbutton. The timing operation will now begin and elapsed time will be displayed. When the relay contacts open, the timer will halt and elapsed time will be held in the display.

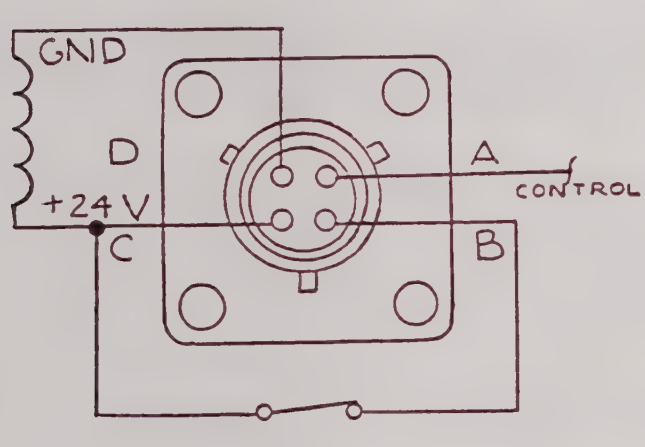


Figure 2-2. Relay timer connections for solid-state delay dropout relays.

2-114. Making Power Input Connections

2-115. Apply power to the FT-50010 as follows:

1. Make power connections to the DC source as shown in Figure 2-3. Pin "A" is the DC (+) input, pin "C" is DC (-), and pin "B" is earth ground.

2. Place the power switch to the ON position. The green power indicator adjacent to the power switch should come on. All four displays should also come on.

3. The instrument is now ready for operation.

CAUTION:

TO PREVENT POTENTIAL FIRE HAZARD OR DAMAGE TO THE INSTRUMENT, THE POWER FUSE SHOULD BE REPLACED ONLY WITH A 3A AGC FAST-ACTING 250V FUSE.

2-116. The FT-50010 Electrical Systems Test Set is to be operated from a dc power source capable of delivering 20 to 34V at 3A. The power input is protected by a 3A AGC fast-acting 250V fuse located directly above the power input connector.

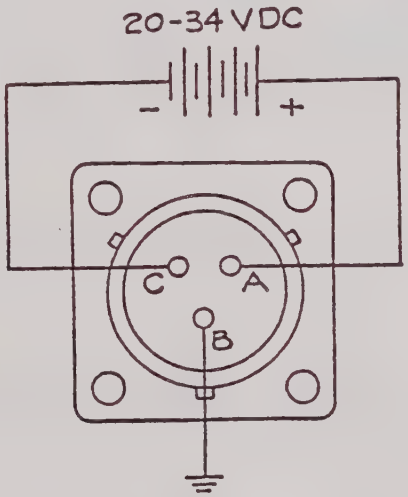


Figure 2-3. Power connections to the FT-50010, to the connector labeled "24V 3A MAX".

SECTION 3
THEORY OF OPERATION

3-1. INTRODUCTION

3-2. This section contains an overall functional description and detailed circuit analysis of the FT-50010. Simplified circuit diagrams are provided, as necessary, to supplement the text. Detailed schematics are available in Section 7 of the Service Manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The FT-50010 is functionally divided into nine isolated subsections and associated power supplies. This isolation is achieved using four high frequency inverter transformers, T1-T4. The transformers have been designed to provide isolation to 350 volts from primary to secondary and from secondary to secondary.

3-5. Power for the inverter supplies is provided by a single switching preregulator that in turn is powered by an external dc input of between 20 and 34 volts.

3-6. The preregulator also provides an oscillator output signal that is used by the inverter drive logic to develop two non-overlapping square wave outputs for driving the inverter transformers. These signals are buffered by the transformer drive circuitry, T1 - T4 drive.

3-7. There are four analog busses in the FT-50010 circuitry that, along with a series of switches, provide an interface between the various inputs and outputs and the multimeter, frequency counter, and thermometer sections.

3-8. The thermometer input bus connects the thermometer front end via input select switches, S2, S26, and S27 to either of two thermocouple input assemblies, and/or to the thermometer calibrator. S26 and S27 are interlocked so that only one of the T/C inputs can be selected at a time. However, the calibrator can be connected through S2 to the thermometer input at any time. The calibrator output is then available at the T/C (+) and T/C (-) terminals of the input assembly that is selected. In this configuration the thermometer section becomes a calibration source for testing and calibrating external thermocouple indicators.

3-9. The frequency counter input bus connects the counter input circuitry via S5, S6, S7 and S8, to either of the two internal frequency sources or to either of two external frequency inputs. These 4 switches are interlocked so that only one input can be connected to the counter.

3-10. There are two multimeter input busses; a voltage input bus and a current input bus. The voltage bus connects the multimeter V/kΩ input via input select switches S29 through S34 and S36 to either of the two internal frequency sources, either of the two external frequency sources, either of the two dc voltage sources, or to the external multimeter V/kΩ input.

3-11. The current bus connects the multimeter mA input via S35 and S36 to the internal current source or to the external multimeter mA input. All input select switches, S29 through S36 are interlocked.

3-12. Note that on the schematic diagrams each power supply output voltage is followed by another number enclosed in parentheses. This number indicates that each supply is referenced to the supply return that is marked with the same number. For example, +32V (6) is a +32 volt supply referenced to supply return marked 6.

3-13. Note also that the relay timer connector in the relay timer section is referenced to the preregulator return. The timer is not isolated from this supply, nor is it isolated from the external power source.

3-14. BLOCK DIAGRAM ANALYSIS

3-15. Introduction

3-16. A BLOCK DIAGRAM DESCRIPTION OF THE FT-50010 IS GIVEN IN THE FOLLOWING PARAGRAPHS. EACH DESCRIPTION IS SUPPORTED BY A DETAILED SCHEMATIC IN SECTION 7 OF THE SERVICE MANUAL.

3-17. Temperature Section

3-18. The temperature section of the FT-50010 consists of a thermocouple thermometer with digital display, a thermocouple simulator (calibrator) and two thermocouple input assemblies. Circuit analysis for the thermometer includes description of the input assembly circuitry. The calibrator is covered in its own section later.

3-19. THERMOMETER

3-20. In operation the thermometer section executes a continuous series of measurement cycles to update the temperature display. The measurement cycle is controlled entirely by a microcomputer and includes three major subcycles; the auto-zero, integrate, and read periods. Each subcycle controls the operation of a dual-slope integrating, analog to digital converter.

3-21. The circuitry can be divided into two sections; analog and digital. The digital section is covered first.

3-22. Digital Section

3-23. This circuitry includes a single chip microcomputer (U4), with a 2048 x 8 bit EPROM "piggybacked" to it; a CMOS hex open drain buffer; a 32 bit serial in/parallel out shift register (U1 on the display board); a backplane oscillator (U2 and associated circuitry on the display board), and a liquid crystal display. Also included is a power-on reset (por) circuit consisting of CR19, CR20, one section of U14, and associated circuitry.

3-24. The function of the digital circuitry is to convert the non-linear thermocouple probe voltage, as measured by the analog section, into a linear digital display, and to provide the necessary control signals to the analog section.

3-25. The microcomputer and EPROM assembly contain all operating program data, control logic and linearizing capability, as well as display data and update signals. Linearization of the non-linear input signal is accomplished by selecting one of eight programs which compute the correct temperature using a 4th order curve-fit approximation of the probe output. The operating program is selected to match a particular thermocouple type. Selection is achieved by presenting the microcomputer with a binary encoded number corresponding to the thermocouple type in use. This number is generated by the T/C type select switch on the front panel.

3-26. Measurement data is continuously clocked out of the microcomputer in a decoded seven segment, bit serial, character serial format and presented to the serial input of a 32 bit shift resister, U1 on the display board. The shift register drives the display with 32 parallel bits of segment, polarity, decimal point, and temperature scale (°C, °F) information. The square wave drive signal required by the display is generated by driving the true/compliment input (Pin 1) of the shift register with the backplane signal. This causes the register outputs to toggle between the positive and negative true states at the backplane frequency.

3-27. The microcomputer also provides six measurement control signals that determine the configuration of the analog circuitry during the various sub-cycles of the measurement routine. These signals are buffered by U3 and then used to control the off/on states of several FET switches.

3-28. Analog Section

3-29. The analog circuit is shown in simplified form in Figure 3-1. It consists of the thermocouple input and reference junction compensation circuit (located on the two T/C input assemblies); two voltage references, a buffer amplifier, an integrator, a gain stage, a comparator, the FET switches, and an open thermocouple detect circuit.

3-30. Input signals present on the T/C input connector are passed through a low pass R-C input filter and appear at FET switch Q15. Diodes provide overvoltage input protection.

3-31. To compensate for error voltages present on the thermocouple input terminals, a reference junction compensation circuit is employed. This consists of an isothermal block, a pair of screw type input terminals, and a temperature sensing transistor.

3-32. The isothermal block maintains a negligible temperature differential between the input terminals and the sensing transistor. Thermocouple voltages introduced by the dissimilar metals at the input terminals vary as the isothermal block adjusts to ambient temperature. Temperature changes are sensed by the forward biased transistor to produce a correction voltage. This correction voltage is present at FET switch Q17 and is sampled by the analog circuitry every twelve measurement cycles. This reading is stored in memory and used by the microcomputer to compute the correct temperature display.

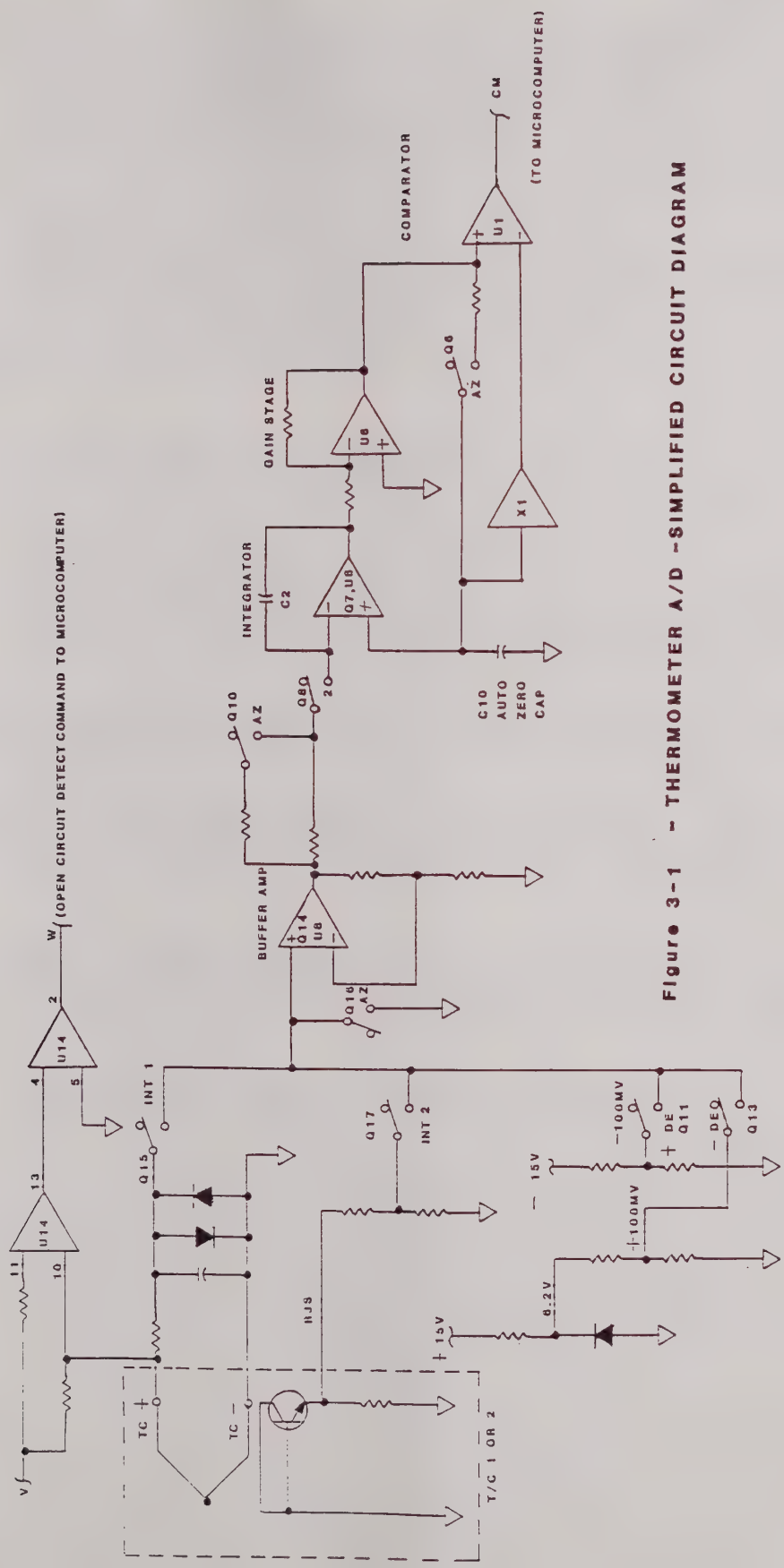


Figure 3-1 - THERMOMETER A/D -SIMPLIFIED CIRCUIT DIAGRAM

3-33. There are two reference voltages required by the measurement circuit. A +100 mV reference is taken off a discrete wire wound resistor network which is supplied by a precision 6.2V dc reference source. This +100 mV reference appears at FET switch Q13. A -100 mV reference is taken off another resistor network supplied by the -15V power supply, and appears at FET switch Q11. The -100 mV reference is used when measuring positive inputs and the +100 mV reference is used for negative inputs.

3-34. The -100 mV reference is not a precision source. In order to maintain measurement accuracy for positive inputs, this reference is sampled every twelve measurement cycles and compared to the precision +100 mV reference. The resulting ratio is used by the microcomputer to "calibrate" the -100 mV reference and compute the proper temperature display.

3-35. Measurement Routine

3-36. The buffer, integrator, gain stage, and comparator amplifiers combine to perform the actual measurement function. Refer to Figure 3-2 for measurement cycle waveforms.

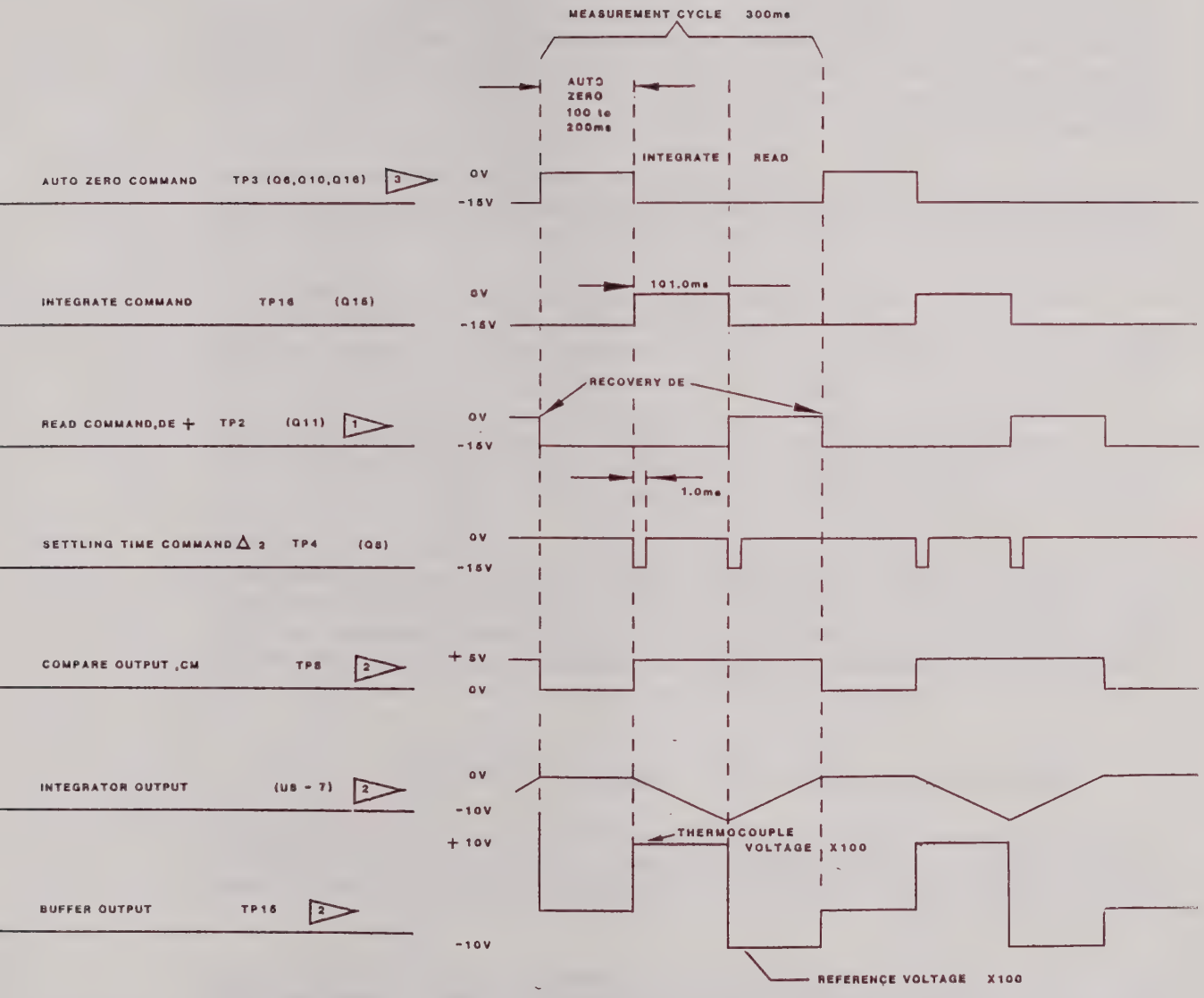
3-37. The microcomputer initiates the measurement routine by generating an auto zero command. This closes FET switches Q16, Q10, and Q6. Q16 zeros the input to the buffer amplifier. With Q10 and Q6 closed, the integrator and gain stage are placed in a closed loop configuration that allows the auto-zero capacitor (C10) to charge to a value which is proportional to the algebraic sum of all the offsets present in the buffer, integrator, and gain stages.

3-38. After 100 to 200 ms the microcomputer terminates auto zero and Q16, Q10, and Q6 are opened. The auto zero capacitor retains the offset voltage for use later in the measurement cycle.

3-39. The microcomputer then generates an integrate command that closes Q15. On the leading edge of the integrate command Q8 is opened for a 1 ms settling period (delta 2). After 1 ms Q8 is closed and the thermocouple input voltage is applied through Q15, the buffer amplifier, and Q8 to the integrator for exactly 100 ms.

3-40. As the integrator capacitor charges, the integrator drives the comparator output to either 0 or +5V, depending upon the polarity of the unknown input. The microcomputer senses the state of the comparator at this time in order to determine which reference voltage to choose during the next measurement subcycle.

3-41. After a total of 101 ms the microcomputer terminates the integrate period and Q15 and Q8 open. The integrator capacitor has now been charged to a level which is proportional to the thermocouple input voltage.



1 DE IS GENERATED FOR POSITIVE INPUT VOLTAGES. NEGATIVE INPUT VOLTAGES ENABLE THE DE - MODE WHICH IN TURN OPERATES FET SWITCH, Q13.

2 WAVEFORM IS SHOWN FOR POSITIVE INPUT VOLTAGE. IT IS INVERTED FOR NEGATIVE INPUTS. SHOWN FOR FULL SCALE INPUTS.

3 THE Q NUMBERS IN PARENTHESIS REPRESENT FET SWITCHES OPERATED BY COMMANDS.

Figure 3-2 THERMOMETER A/D CONTROL SIGNALS

3-42. The microcomputer then generates either one of two read commands, depending upon the state of the comparator output during the integrate period. If a positive input has been sensed, Q11 is closed and the -100 mV reference is applied to the buffer amplifier. If a negative input has been sensed, Q13 is closed and the +100 mV reference is applied to the buffer.

3-43. After a 1 ms settling period Q8 is closed and the buffer output voltage is applied to the integrator input. This causes the integrator capacitor to discharge at a linear rate determined by the reference voltage. When the integrator voltage reaches the comparator trip point, which is referenced to the offset voltage stored on the auto-zero capacitor, the comparator changes state. This signals the microcomputer to terminate the read period.

3-44. The time required to discharge the integrator during the read period is directly proportional to the thermocouple input voltage. The microcomputer performs a precise time keeping function during the read period, and stores the resulting data in memory.

3-45. Every twelve measurement cycles the correction voltage output of the reference junction compensation circuit is sampled. The measurement routine is the same as described above. However, during the integrate subcycle, Q15 remains open and Q17 is closed by the INT 2 command from the microcomputer.

3-46. The microcomputer then uses the thermocouple input measurement data, the reference junction measurement data, and the thermocouple linearization data to compute the unknown temperature. The resulting information is then clocked out to the display.

3-47. Poor input connections or faulty thermocouple probes are detected by an open circuit detector. This consists of U14 and associated circuitry. This circuit senses the impedance at the T/C input by comparing the loading (and therefore amplitude) of a square wave, applied to the input of the thermometer, to a reference square wave. If the reference is exceeded, one section of U14 flags the microcomputer that an open circuit condition has been detected (a nominal 2 kΩ impedance). The microcomputer then sends an open circuit code (O.C.) to the display.

3-48. THERMOCOUPLE CALIBRATOR (Refer to Figure 3-3)

3-49. The calibrator consists of a precision voltage reference, a non-inverting amplifier (U20) an inverting amplifier, U21 and a voltage divider network. The divider network consists of the output adjustment potentiometers (located on the front panel) and precision fixed resistors (located on the main circuit board).

3-50. The voltage reference output is applied to the non-inverting input of unity gain amplifier U20 and to the inverting input of U21. The resulting outputs are applied to opposite ends of the parallel combination consisting of the fine and coarse output controls. The algebraic sum of the voltages present on the sliders of the output controls appears at one end of the T/C signal select switch (S2).

3-51. When switch S2 is depressed (CAL OUT position) the calibrator output is connected to the thermometer input and to the T/C+ terminal of the selected T/C input.

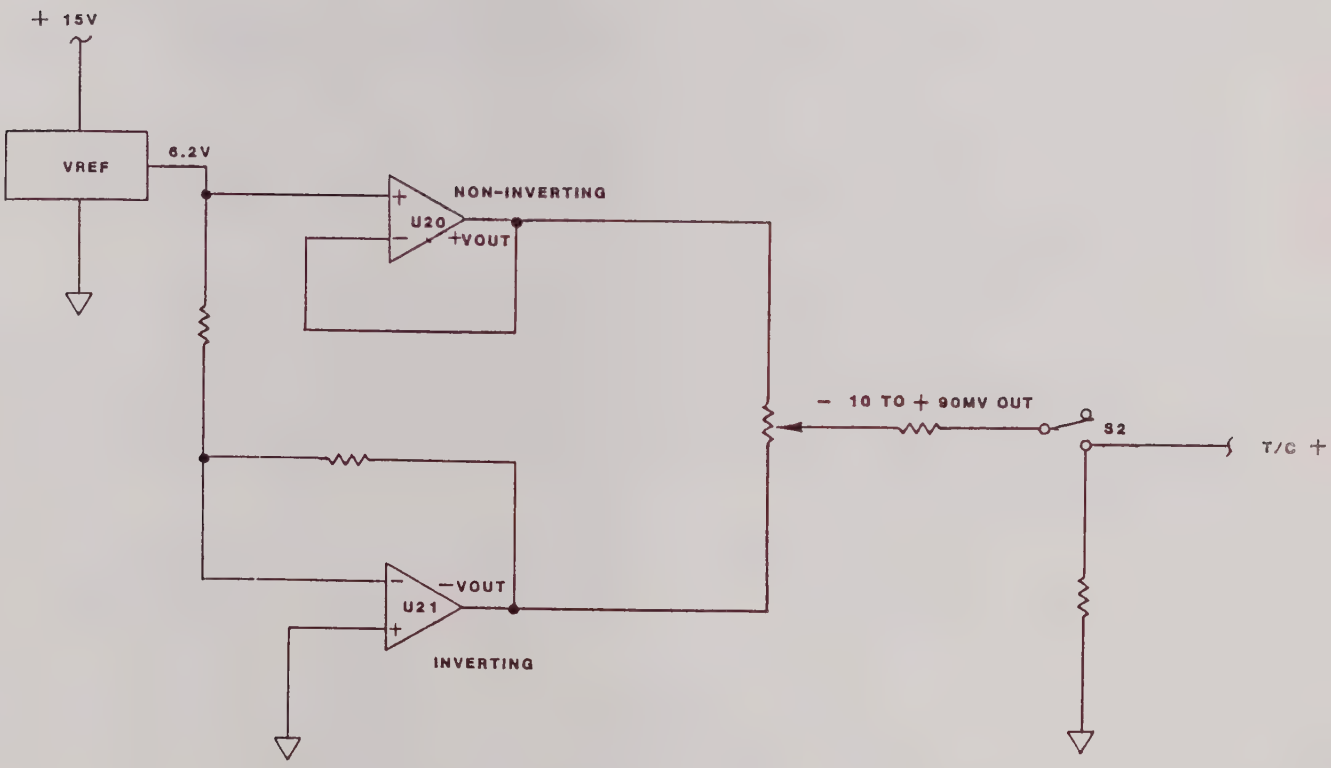


Figure 3-3. T/C Calibrator -- Simplified Circuit Diagram

3-52. Frequency Counter (Refer to Figure 3-4.)

3-53. The frequency counter consists of an input conditioning circuit (Q101, R114, U103 and associated circuitry); a time base and counter control circuit (Y101, U101, U102); a counter string (U101, U103, U104 on the display board); an overflow detect circuit (U102 on the display board); a power on reset circuit; and a digital display.

3-54. The input signal is taken from one of the two internal frequency sources or one of the two External Input Connectors on the front panel, depending on the setting of the switches S5, S6, S7, and S8 in the Audio Frequency Section. Signals from the internal sources are connected directly into the counter front end. Signals from the external input connectors are first applied across a 250 kΩ potentiometer. The setting of the potentiometer reduces the input amplitude so that noise riding on the input signal does not trigger the counter. The input is then ac coupled and applied to the gate of Q101 through a low pass filter. Hex inverter U103 squares and level shifts the signal present at the source of Q101 and applies it to pin 8 of NAND gate U105.

3-55. The counting function is controlled by three control signals; GATE, LATCH, AND RESET; that are generated by Y101, U101, and U102 and gated by U105. Y101 supplies a master time base frequency of 5.24288 MHz. U101 is a monolithic oscillator/controller and U102 is a decade counter configured as a divide-by-6 ring counter.

3-56. The "GT" signal at U101, pin 13 is a square wave with a 50% duty cycle and a period of 200 ms. It is inverted by 1/6 of U104 and applied to the clock input of U102. At the beginning of a measurement cycle the "CO" output of U102 transitions from LO to HI, enabling 1/4 of U105. This allows the input frequency to appear at the clock input of the counter string (U103, pin 2 on the display PCB). The "CO" output of U102 remains HI for five cycles of the "GT" input (exactly 1 second). The "CO" output then goes LO, removing the input frequency from U103, pin 2 on the display PCB.

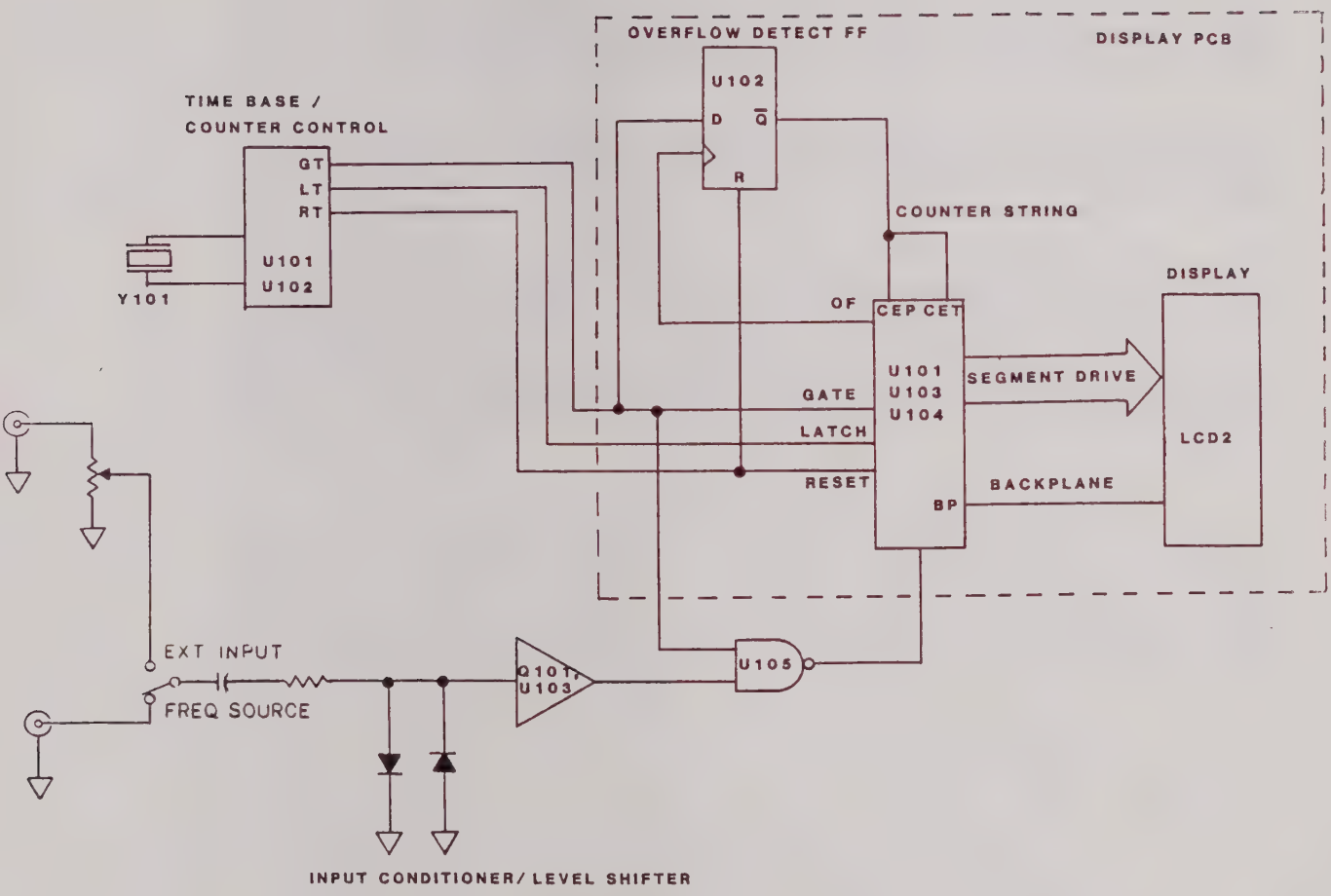


Figure 3-4. Frequency Counter -- Simplified Circuit Diagram

3-57. The "LT" and "RT" signals, present at pins 2 and 14 of U101 on the main PCB, are short pulses (312 us) that occur once during each cycle of the "GT" signal. The transition of the "GT" signal that causes the "CO output of U102 to go LO, also causes the "Q5" output of U102 to go HI. The "Q5" output remains HI for one full cycle of the "GT" input (200 ms). This allows the LATCH signal to appear at pin 34 of U101 and pin 1 of U104 on the display board. This latches the accumulated count from the counter string to the liquid crystal display. The RESET signal then appears at pin 33 of U101 and pin 1 of U103 on the display PCB. This resets the counter string in preparation for the next measurement cycle.

3-58. 200 ms after the end of the gate period, "Q5" of U102 on the main PCB goes LO. At the same time the "Q6" output of U102 goes HI, resetting U102, and the measurement cycle begins again. The total measurement/ display update period is then 1.2 seconds.

3-59. The counter string consists of a 4-1/2 digit monolithic counter/decoder/driver (U101); a BCD counter (U103); and a BCD to seven segment decoder/latch (U104). U103 and U104 comprise the least significant digit of the counter string.

3-60. Overflow detection is provided by 1/2 of AD-type flip flop, U102 on the display PCB. It tests the state of the GATE signal when the carry output "OF" of counter U101 transitions from a logical "1" state to logical "0". If "OF" transitions when the GATE signal is still active (logical "1"), the Q output of U102 goes LO and disables BCD counter, U103. At the same time the counter string "wraps around" to an all zero count, and pin 27 of U101 goes true, which lights all decimal points on the display. The display is then 0.0.0.0.0, indicating that an overflow condition has occurred.

3-61. Frequency Sources

3-62. In the following discussion all component designators apply to frequency source No. 1. However all operational theory covered also applies to frequency source No. 2.

3-63. The frequency sources of the FT-50010 consist of a voltage controlled oscillator/function generator, an output driver stage, and a dc offset circuit.

3-64. The VCO/function generator section consists of U109 and associated circuitry. U109 provides sine and square wave outputs. Output frequency is a function of the voltage level on Pin 8 of U109, and can be swept from 40 Hz to 15 kHz by adjusting the fine and coarse frequency controls (R150, R151) located on the front panel.

3-65. The VCO output waveform is connected through function select switch S4 (located on the front panel) to one end of the amplitude control, R152 (located on the front panel). Output amplitude is adjusted by varying the amount of VCO output that is applied to the driver stage.

3-66. The output driver stage consists of U111, U108, Q102, Q103, and associated circuitry. These components operate together as a power amplifier with complimentary outputs, providing both voltage and current gain. U108 also provides output current limiting via 10Ω resistors R126 and R127 (see also schematic, sheet 6, revision C or prior). On serial number 4850001 and greater (and on units retrofitted with daughter board 872812), the above semiconductors are replaced by U120 and use a 3.9Ω current limiting resistor for R126 (see also schematic, sheet 6, revision D or greater).

3-67. The offset voltage section consists of a variable bi-polar voltage reference and a class AB amplifier with a complimentary output (U110, Q105, Q104 and associated circuitry). This circuit is enabled when the offset switch (S43) on the front panel is in the ON (OUT) position. With the offset enabled, frequency source output LO is connected to offset supply common. The offset amplifier output then elevates the entire frequency source circuit by an amount that is adjustable (via R153 on the front panel) between -18V dc and +18V dc.

3-68. Multimeter (Refer to Figure 3-5.)

3-69. The multimeter section of the FT-50010 consists of input protection circuitry, and input divider, a precision voltage reference, an rms to dc converter, a monolithic analog to digital converter, a digital display, and range and function switching circuitry.

3-70. Protection for the V/kΩ input is provided by R202, Q201, RT201, RV201, RV202, and RV203. Protection for the mA input is provided by fuses F1, F2, CR201 and U207. F2 is in series with F1 to prevent damage to the instrument if the open circuit voltage of the circuit being measured exceeds 250 volts.

3-71. The input divider consists of a precision resistor network, U206, and associated compensation circuitry. The input divider scales the unknown input to a level that is within the range of the analog to digital converter. The compensation circuitry maintains a flat divider frequency response when measuring ac inputs.

3-72. The precision voltage reference consists of band-gap reference, U202, and associated circuitry. It provides the reference voltage required by the A/D converter.

3-73. The rms to dc converter consists of U201, U203 and associated circuitry. When measuring ac voltage and current the rms to dc converter provides a dc output to the A/D converter that is equal to the rms value of the input waveform.

3-74. The analog to digital converter consists of U201 and associated circuitry on the display board. U201 contains all the digital logic and most of the analog circuitry required to convert the scaled analog input to a digital representation of that input. It also contains all the decoding logic and drive circuitry required by the display.

3-75. The conversion process utilizes the same dual-slope integration technique outlined in the thermometer theory (see Thermometer, Digital Section). The A/D converter can be configured to operate in either of two internal ranges, determined by the voltage level on Pin 38 of U201. When measuring any function on the 0.2 and 20 ranges, U201 functions as a 200 mV full scale converter. When measuring on the 2, 200, and 2,000 ranges, U201 is configured as a 2 volt full-scale converter.

3-76. The range and function switches S11-S20 configure the multimeter input circuitry to accommodate the type and level of input to be measured. The range switches also select the A/D converter range and decimal point location on the display.

3-77. Figure 3-6 shows input circuit configuration in the various measurement modes. Voltage and current measurements should require no further explanation. However, because of the unique measurement method used, the resistance and conductance functions will be explained.

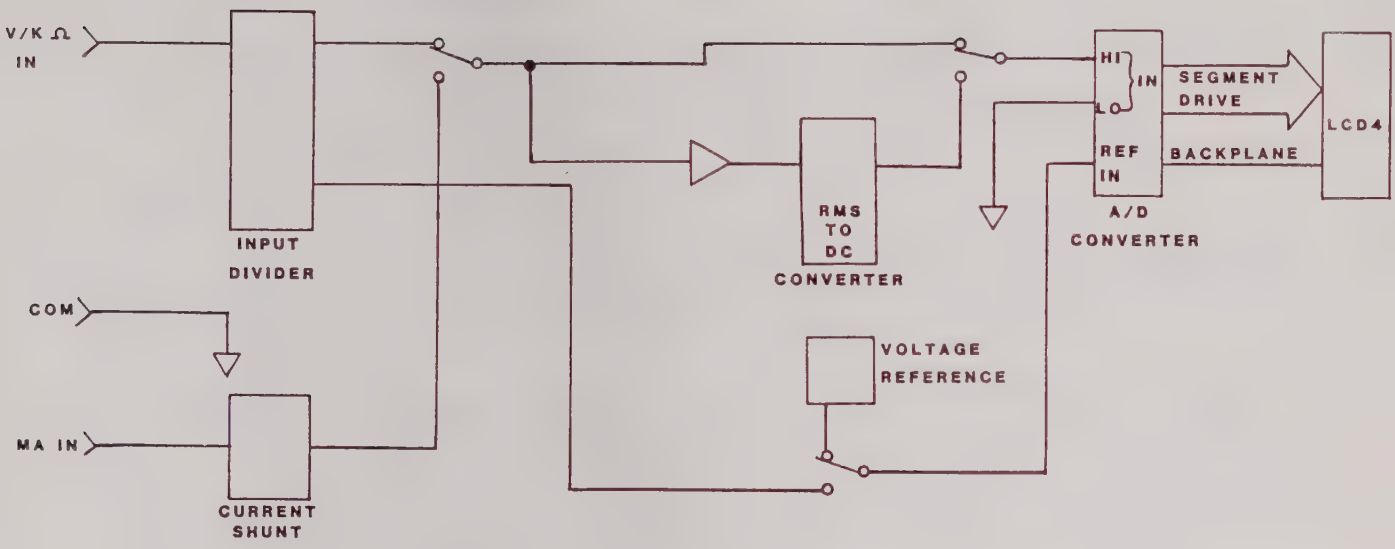


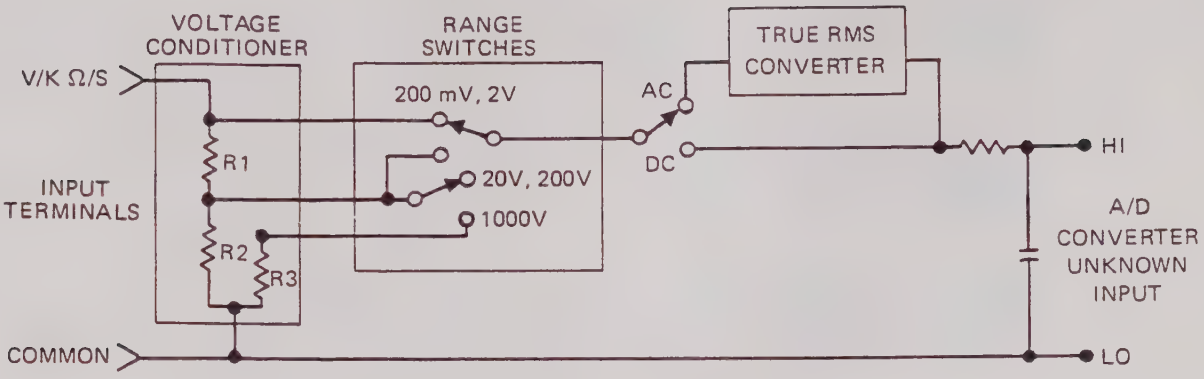
Figure 3-5. Multimeter -- Simplified Circuit Diagram

3-78. In the resistance measurement mode the voltage reference is removed from the A/D converter. The reference voltage is then supplied by the drop across a precision resistor selected by the range switches. A voltage source is connected across the series combination of this precision resistor (part of the input divider network) and the unknown resistance.

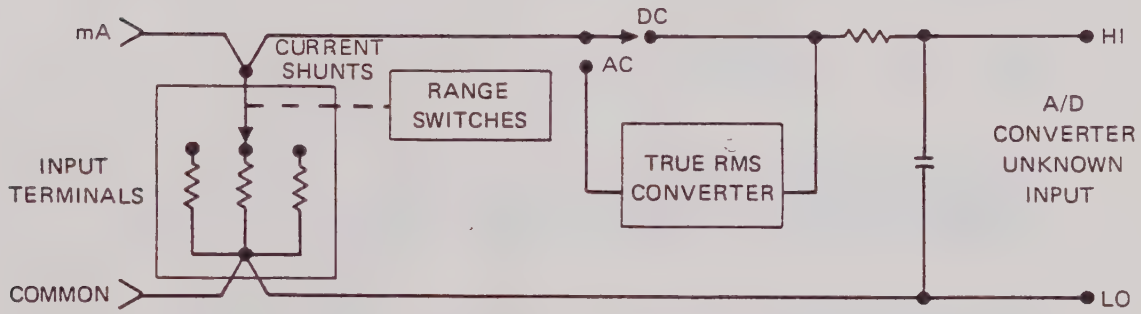
3-79. The resulting voltage drop across the unknown resistance is applied to the integrator during the integrate period. During the read period the voltage across the precision resistors is used to discharge the integrator. This operation measures the ratio of the voltage drops across the two resistances and, therefore, the ratio of the unknown resistance to the (known) precision resistor. The resulting reading is then latched out to the liquid crystal display.

3-80. When measuring conductance (the inverse of resistance) the voltage reference is also removed from the A/D converter, as it is for resistance measurements. However, in this case, the voltage drop across the precision resistor is used to charge the integrator during the integrate period. The voltage drop across the unknown resistance is used to discharge the integrator during the read period.

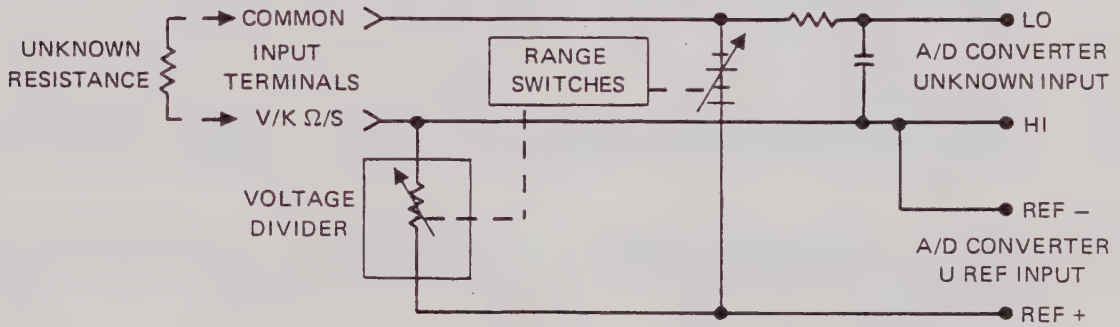
3-81. The result of this operation is the ratio of the (known) precision resistor to the unknown resistance, or the inverse of the resistance. The resultant reading is then latched out to the liquid crystal display.



A. VOLTAGE MEASUREMENTS



B. CURRENT MEASUREMENTS



C. RESISTANCE AND CONDUCTANCE MEASUREMENTS

Figure 3-6. Multimeter Input Signal Conditioner

3-82. DC Voltage Sources

3-83. In the following discussion all component designations apply to dc voltage source No. 1. However, all theory covered applies to both dc voltage sources.

3-84. The dc voltage sources consist of a voltage reference, an error amplifier, and emitter follower output stage, and an output protection circuit.

3-85. The output of band-gap voltage reference, U252, is applied to a precision voltage divider network. The division ratio of the network is determined by the position of the range select switches, S37 and S38, located on the front panel, and by the position of the fine and coarse amplitude controls R264 and R265 (also on the front panel).

3-86. Output regulation is provided by an error amplifier, 1/2 U251. The voltage level at the output is compared to the adjusted reference voltage and the resulting error output controls conduction of emitter follower, Q257. The other half of U251, Q252, R247, and associated bias components comprise a power sharing network. The amplifier (U251) senses the output voltage and current and by varying the conduction of Q252, adjusts the voltage across Q257 to limit power dissipation in that device to a safe level.

3-87. Output short-circuit protection is provided by Q251 and R262. At a current of approximately 600 mA the voltage drop across R262 is sufficient to turn on Q251 and prevent any further increase in output current.

3-88. DC Current Source

3-89. The current source consists of a voltage reference, an error amplifier, and a Darlington pair output stage.

3-90. The output of band-gap voltage reference, U255, is applied to a precision divider network. The division ratio is determined by the position of the fine and coarse output controls, R289 and R290.

3-91. Range selection is made via switches S41 and S42, located on the front panel. These switches select either one of two resistors (R282 or R283) that, in turn, determine the voltage level fed back to the output regulation stage.

3-92. Output regulation is provided by error amplifier U256. The voltage level at the top of range resistor R282 or R283 (depending on the range selected) is compared to the adjusted reference voltage. The resulting error output controls the conduction of Darlington pair Q255 and Q256. Q256 is located on a heat sink mounted on the range control switch deck.

3-93. Relay Timer

3-94. The relay timer section of the FT-50010 consists of a 10 Hz clock, gating logic, a monolithic 19,999 count counter/driver, timer control switches, an overflow detect circuit, and a liquid crystal display.

3-95. The clock circuit consists of a 38.4 kHz crystal, Y301 and a divider string (U301, U302, and U304) which produce a 10 Hz timebase output. This output is gated by U303 and applied to the counter (U301 on the display board).

3-96. During the timing operation transitions of the 10 Hz clock are counted by counter U301 on the display board. U301 updates the display on every count (every 0.1 seconds). At the end of a timing cycle the accumulated count is held in display until the START switch, S25, is released.

3-97. The gating circuitry consists of U302, U303, U305 and associated circuitry on the main PCB. R306 and R307 convert the relay contact status into 0 and +5V logic levels. U303 is a quad, two input NAND gate with Schmitt trigger inputs. The Schmitt trigger inputs prevent switching transients from appearing at the counter input.

3-98. Configuration of the gate circuitry is dependent upon the timing mode selected by S22 and S23. Figures 3-7 and 3-8 are simplified circuit diagrams that show circuit configuration for each timing mode. For simplicity the delay pick-up (S22) and delay drop out (S23) switches are not shown.

3-99. DELAY PICK-UP TIMING

3-100. Refer to Figure 3-7 for delay pick up timing. In this mode, the timer energizes the relay coil and then measures the time that it takes for the relay contacts to close.

3-101. The timing cycle begins when the START switch, S25 is depressed, which causes two things to occur: 1) +24 volts is applied to one end of the relay coil through S25-B which energizes the relay; and 2) a low signal from S25-D (inverted) removes the reset and enables the counter. At the end of the delay period the relay contacts close and +24 volts is applied through the relay contacts and S25-A to R306 and R307. This disables the counter, ending the timing cycle. On serial number 4850001 and greater an internal 1A fast-blow fuse (F301) helps to protect the relay timer section (see also schematic, sheet 9, revision D or greater).

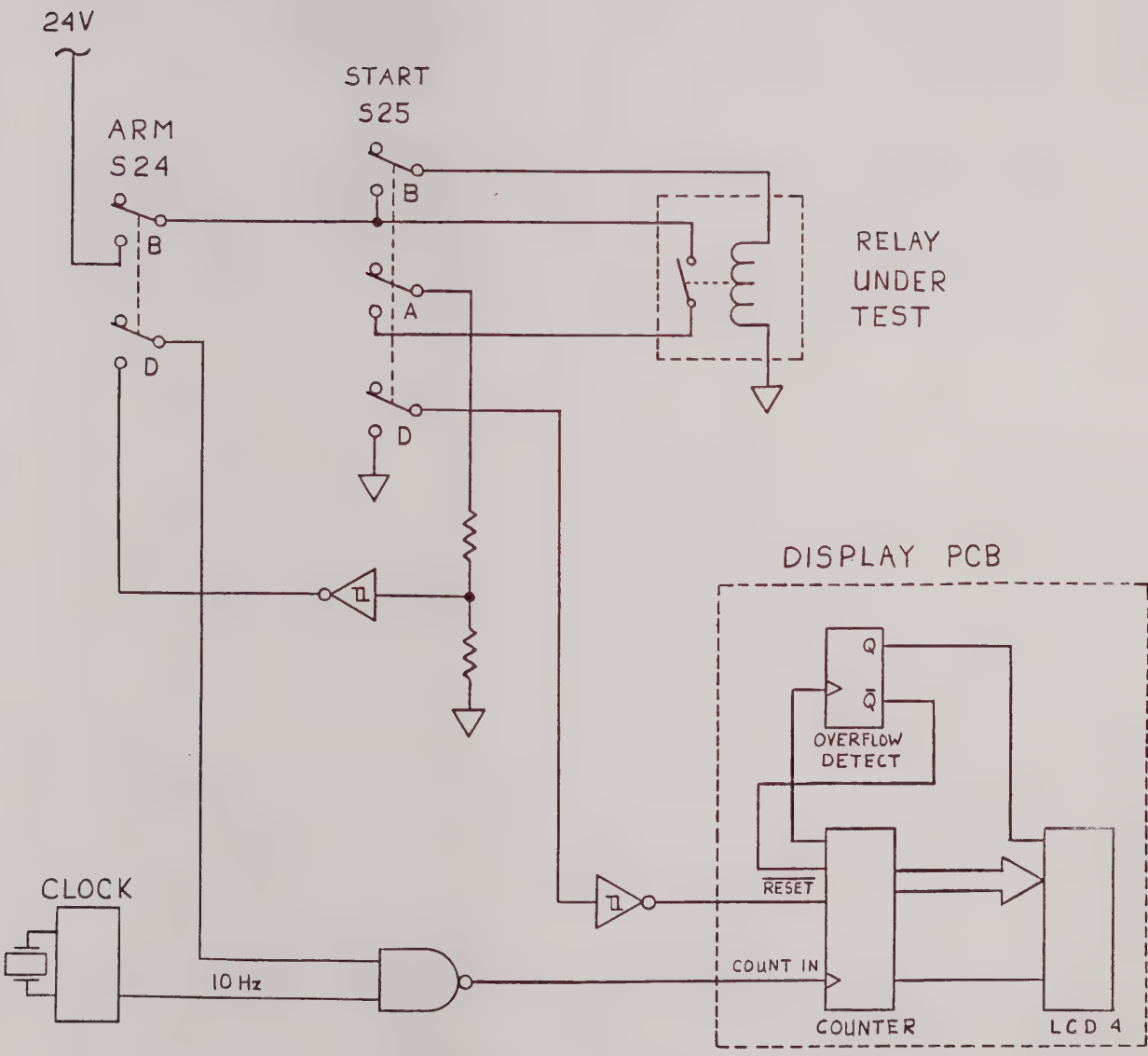


Figure 3-7. Relay Timer, Delay Pick-Up Mode

3-102. DELAY DROP-OUT TIMING

3-103. Refer to Figure 3-8 for delay drop-out timing. In this mode the relay is energized when the ARM switch is depressed. The timer then de-energizes the relay and measures the time that it takes for the contacts to open.

3-104. The timing cycle begins when the START switch, S25, is depressed. S25-B opens and the relay coil is de-energized. At the same time +24 volts is applied through the closed relay contacts and S25-A to R306, R307, and the input logic gates. This signal and the 'unreset' signal from S25-D enable the counter. At the end of the delay period the relay contacts open and +24 volts is removed. This disables the counter, ending the timing cycle.

3-105. Counter overflow is detected by U302 on the display board. U302 is a dual D-type flip-flop configured as a divide-by-two counter. Pin 28 of U301 will transition from high to low on count 10,000 and count 20,000 of the counter. If the timer is not halted before count 20,000, the second "Q" output of U302 will go high, turning on all the decimal points and segments A, D, E, and F of the most significant digit in the display. At the same time the second output "±" of U302 will go low, disabling the counter. The resulting display will be frozen at 0.0.0.0.0, indicating that an overflow condition has occurred.

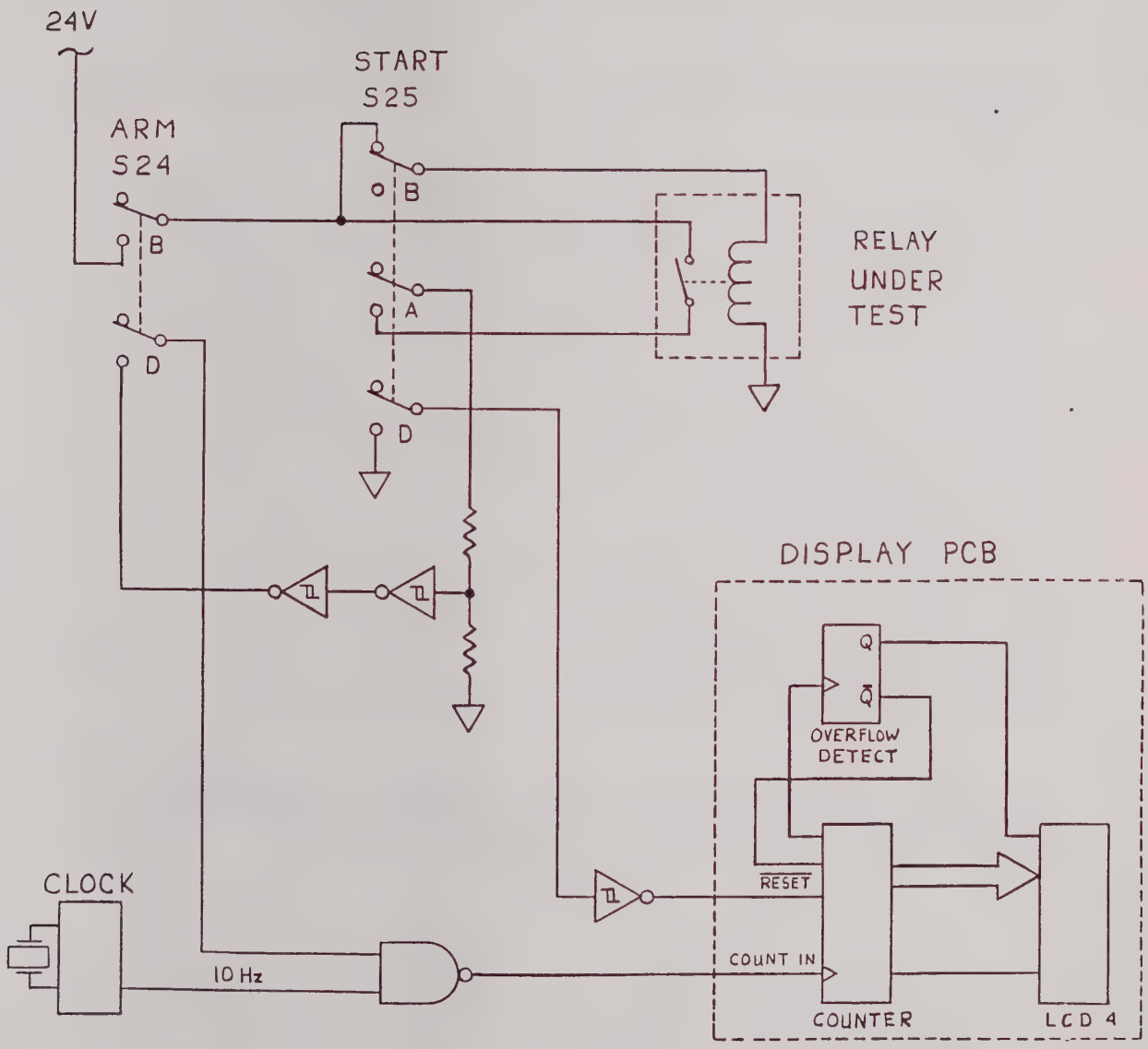


Figure 3-8. Relay Timer, Delay Drop-Out Mode

3-106. Power Supplies

3-107. PRE-REGULATOR

3-108. The pre-regulator provides a regulated 12V dc to the inverter supplies from an unregulated 20 to 32V dc input. The input voltage is switched ON and OFF by the pre-regulator as required to maintain the proper inverter supply voltage. The pre-regulator consists of Q401 and Q402, an energy storage element, L401 and gain setting resistors R409, R410, and R434.

3-109. The pulse width modulator U401 contains most of the circuitry required for voltage regulation, including a 5V dc regulated reference supply. This reference supply is divided in half by resistors R401 and R402 to provide a nominal 2.5V dc reference at U401 pin 2.

3-110. Q402 is turned on at regular intervals by the PWM, supplying current from the input to L401. When Q402 is turned off by the PWM, the energy stored in L401 supplies the load current requirement.

3-111. The switching frequency of Q402 is constant (about 52 kHz), however, the ON time (duty cycle) of Q402 varies inversely with the input voltage sensed by the PWM through the gain setting resistors. When the voltage drops below the level determined by the reference voltage, the duty cycle of Q402 is increased to supply more energy to the load, raising the voltage. When the regulated voltage sensed by the PWM through the gain setting resistors increases above the level determined by the reference voltage, the duty cycle of Q402 is decreased, lowering the voltage.

3-112. INVERTERS

3-113. The inverter drive logic uses the pulse oscillator output of U401 to generate two inverter drive signals that are 180° out of phase. The oscillator output of U401 is buffered by Q403 and 1/4 of U402 to provide a rectangular pulse of about 1 µs width. This pulse is used by the inverter drive logic consisting of U402 and U403 to generate two non-overlapping rectangular waves with a 1 µs "dead time" between the "high" state of each signal. These signals are buffered by U404.

3-114. The outputs of U404 are capacitively coupled to drive the gates of V-MOS power FETs on the inverter primaries. Each of the pair of FETs alternately pulls current through the inverter transformer primary, with a resulting voltage at the transformer secondaries. These secondary voltages are rectified, filtered and regulated as necessary for each section.

SECTION 4
MAINTENANCE

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains maintenance information for the Solar Turbines FT-50010 Turbine Electrical System Test Set. Service Information, General Maintenance, Access Procedures, Performance Tests and Calibration Adjustments are included. The performance and calibration procedures for each part of the instrument are located in the following sections of this manual (note that section numbers are given, rather than page numbers):

	VERIFICATION Section	CALIBRATION Section
Thermometer	4-3-1	4-13
Thermocouple Input Module	4-3-1	4-14
Calibration Output	4-3-2	*
Multimeter:		
Display	4-4-1	*
Resist./Conductance	4-4-2	*
Volts	4-4-3	4-10
Current	4-4-5	*
Frequency Counter	4-5	4-11
Frequency Sources	4-6	4-12
DC Voltage Sources	4-7	*
DC Current Sources	4-8	*
Relay Timer	4-9	4-16

4-3. The Performance test is recommended as an acceptance test when the instrument is first received, and later as a preventive maintenance tool to verify proper operation and accuracy. To maintain the one-year specifications, the instrument must be calibrated at one-year intervals.

EQUIPMENT TYPE	REQUIRED SPECIFICATIONS	WHERE USED	RECOMMENDED MANUFACTURER
Thermocouple Wires	Type K preferred	Temperature Section	Omega
Mecury Thermometer (degrees C or F)	0.02 deg. C Resolution 0.05 deg. F Resolution	Temperature Section	Princo Model ASTM56C Princo Model ASTM56F
Dewer Flask/Cap	1 Pint Capacity	Temperature Section	Thermos
Voltage Divider	100:1 Ratio 0.005% Ratio Accuracy	Temperature Section	Fluke Y2022, Fluke 720A or (Shunt Output Fluke 750A with 1uF cap)
DC Voltage Calibrator	0-10 V dc Output 0.002% accuracy 100 uV Resolution	Temperature	Fluke Model 343A
Voltmeter	0.005% Accuracy 1 uV Resolution	Various	Fluke 8800A
Multimeter Calibrator	dc voltage: 0 to 1000V±.05% ac Voltage: 100 Hz - 0 to 200V ± .05% - 0 to 750V ± .8% 1 kHz - 0 to 250V ± .05% 10 kHz - 0 to 110V ± .3% 20 kHz - 0 to 20V ± .5% dc current: 0-200 mA ±.04% ac Current: 0-200 uA ±.01% Resistance: 0-10 Mohm in steps of powers-of-ten ±.05%	Multimeter	Fluke 5100A
Frequency Counter	1 Hz Resolution 6 MHz Range	Counter/Relay Timer	Fluke 1952A
Synthesized Signal Generator	110 kHz Range 25 mV to 10V rms Output Amplitude	Counter	Fluke 6011A
Oscilloscope	Dual Trace 30MHz Bandwidth	Frequency Source/ Power Supplies	Tektronix 465
Decade Resistor	Accuracy: 1% Range: 1,111,111 ohm Resolution: .1 ohm	Temperature	General Radio 1434-G
DC Power Supply	20 - 34V dc @ 3A	A21-50	LAMBDA

TABLE 4-1 REQUIRED TEST EQUIPMENT

4-4. GENERAL MAINTENANCE

4-5. Equipment Required

4-6. Table 4-1 lists the equipment required for the verification and calibration procedures.

4-7. Static Awareness

4-8. The FT-50010 contains CMOS circuitry on both the main circuit board and display board. These integrated circuits can be destroyed by electrostatic discharge resulting from careless handling. To prevent this possibility it is important that the following precautions be observed when calibrating or servicing the instrument.

1. Never remove, install or otherwise connect or disconnect PCB's and/or components without first turning the FT-50010 power switch to OFF.

2. All servicing should be performed at a static-free work station. All work surfaces should be grounded. An anti-static bench top covering connected to earth ground is recommended.

3. All service personnel should be connected to earth ground using wrist straps.

4. Keep plastic, vinyl, and Styrofoam out of the immediate work area.

5. Handle circuit boards and integrated circuits by their edges only. Never handle PCB's or IC's by their connectors.

6. Use a grounded tip soldering iron only.

4-9. Cleaning

4-10. Clean the front panel and case with denatured alcohol or a mild solution of detergent and water. Clean dust from the circuit boards with low pressure dry air. Contaminants can be washed from the circuit boards with de-mineralized water and a soft brush (avoid getting excessive amounts of water on the switches).

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These solutions may damage plastic materials used in the instrument. If Freon T.F. degreaser is used, be careful to keep it away from the switch decks. (Freon cleaners remove lubricants from the switches and may force contaminants into them.) Do not handle the PCBs by the connector pins. Oil from the skin contaminates the metal surfaces. Handle the PCBs by the edges only. Improper handling of the main board may also cause static damage. Refer to the manual section on electrostatic damage.

4-11. Fuse Replacement

WARNING

Remove all test leads and disconnect the unit from the power source before attempting fuse replacement.

4-12. The FT-50010 has two fuses accessible on the front panel. F1 is the power fuse and should be replaced, when necessary, with a fast-acting 3A AGC 250V fuse. F2 protects the multimeter mA input and should be replaced with a fast-acting 2A AGC 250V fuse.

4-13. A third fuse, F3, is located inside the instrument on a small input circuit board attached to the FT-50010 front panel. F3 is a 3A 600V fuse which provides additional protection for the multimeter mA input in the event that the test leads are accidently connected to a circuit with a voltage of over 250V. Replacement of this fuse will require the instrument to be opened (see Access Procedure 4-14).

4-14. Access Procedure

4-15. DISASSEMBLY PROCEDURE

1. With the power switch off, disconnect any cables from the front panel of the FT-50010 including the power cable.

2. Remove the six large phillips-head screws from the outside edge of the front panel.

3. Lift the instrument out of the case. This may take several attempts, since it is tight.

4. Remove the two or three self-locking nuts from the studs on the underside of the front panel located near the LCD displays (use a 5/16" hex nut driver).

5. Grasp the panel on the edge opposite the hinge and pull it upward. Lock the panel in the up position with the locking arm located at one side of chassis.

4-16. CLOSING PROCEDURE

Before installation of the instrument into the carrying case, all button caps must be installed on the front panel switches and the front panel of the instrument must be closed and secured by three nuts as follows:

1. Fasten the top of the flexible back shield to the display PWB using the three mounting screws at the tops of the display PWB.

2. Clean off any lint from the face of the LCD's and from the back of the display lens (on the front panel) so that nothing is trapped between the LCD's and lens when the front panel is closed.

3. Close the front panel being especially careful to line up the display bezels with the cutouts in the front panel. If an LCD should bind against the front panel it may fail to operate properly.

4. Exercise all the front panel switches before tightening the front panel securing nuts.

4-17. PERFORMANCE TEST

4-18. The following tests may be used for verifying calibration. The equipment used in the test is specified in Table 4-1. If the instrument should fail to meet specifications in any performance test, calibration can be performed as outlined in the Service Manual. All tests should be conducted with an ambient temperature of 25°C ± 2°C.

4-19. Thermometer Section Verification

4-20. The following procedures verify the thermometer section, followed by the thermocouple Calibration Output section.

4-21. The performance of the thermometer in the FT-50010 can be verified by a test performed either at ambient or at ice point. Either of the tests can be used for initial acceptance or periodic calibration verification in a lab environment. Choose one of these tests to perform. Then go on to test "1." for ambient, or test "2." for ice bath.

1. Ambient Temperature Test -- Construct an ambient lag bath as described below and perform the procedure which follows.

    a. Prepare a thermos type container by drilling two holes in its cap for the mercury thermometer and thermocouple wires or use a standard laboratory cork.

    b. Fill this container with room temperature water.

    c. Replace the cap or cork and insert thermocouple wires and thermometer as shown in Figure 4-1.

    d. Allow bath to stabilize for at least 30 minutes.

    e. Turn the FT-50010 ON and allow it to stabilize for at least 5 minutes.

    f. Connect the calibrator, divider, FT-50010, and lag bath as shown in Figure 4.1.

    g. Select the temperature scale (°C or °F) on the FT-50010 to agree with the mercury thermometer in the lag bath.

    h. Select the thermocouple range corresponding to the thermocouple type in use.

    i. Read the temperature of the mercury thermometer in the lag bath and find the corresponding mV value for this temperature in Table 4-3. Interpolation may be used as necessary.

    j. Algebraically subtract the mV reading found in the previous step from the first value found under the "Divider Output mV" column of Table 4-2, for the thermocouple type in use.

k. Obtain a divider output equal to the result found in the previous step. If the Y2022 divider is used, adjust the dc calibrator for an output equal to the desired divider output times 100. If a Fluke 720A or 750A is used, first adjust the dc calibrator output to an appropriate cardinal point (refer to the divider instruction manual). Then adjust the divider for the proper output.

NOTE: If a Fluke 720A or 750A is used as the voltage divider a 1 μF capacitor must be placed across its output terminals, otherwise the FT-50010 will indicate an open thermocouple condition. The capacitor is not needed if a Fluke Y2022 is used.

l. Verify that the FT-50010 Temperature display reads the value listed in Table 4-2, within the limits specified (90-day or 1 year as required).

m. Repeat steps 9, 10, and 11 for the remaining values in Table 4-2.

n. Example: Assume a lag bath reading of 25.86°C and a K-type thermocouple is in use.

(1) Round the lag bath reading to 25.9°C.

(2) According to Table 4-3, the K-type mV equivalent of 25°C is 1.00 mV. The mV equivalent of 26°C is 1.041 mV. By interpolation the mV equivalent of

$$\begin{aligned} 25.9°C &= 1.000\ mV + 0.9(1.041 - 1.000)\ mV \\ &= 1.000\ mV + (0.9 \times 0.041)\ mV \\ &= 1.000\ mV + 0.037\ mV \\ &= 1.037\ mV \end{aligned}$$

(3) Referring to Table 4-2, the first verification point for K-type thermocouple is -123.3°C. According to the "divider Output mV" column, this corresponds to -4.230 mV. The required divider output should be:

$$-4.230\ mV - 1.037\ mV = -5.267\ mV.$$

(4) A divider output of -5.267 mV should yield an FT-50010 temperature display of -123.3°C ± 0.2°C.

(5) Assuming, again, a lag bath temperature of 25.86°C, refer to the 3rd verification point for K-type thermocouple in Table 4-2. The divider output for a reading of 648.9°C should be:

$$26.975\ mV - 1.037\ mV = 25.938\ mV.$$

2. Ice Bath Temperature Test -- Construct an ice-point lag bath as described below and perform the procedure which follows.

   a. Prepare a thermos type container by drilling two holes in its cap for the mercury thermometer and thermocouple wires or use a standard laboratory cork.

   b. Fill the container with shaved or crushed ice made from distilled water.

   c. Fill the container with enough distilled water so that the ice becomes slush, but not enough to float the ice.

   d. Replace the cap and insert thermocouple wires and thermometer as shown in Figure 4-1.

   e. Turn the FT-50010 ON and allow it to stabilize for at least 5 minutes.

   f. Select the temperature scale (°C or °F) on the FT-50010 to agree with the mercury thermometer in the lag bath.

   g. Select the thermocouple range corresponding to the thermocouple type in use.

   h. Verify the ice bath is at the freezing point (0.0°C, 32°F).

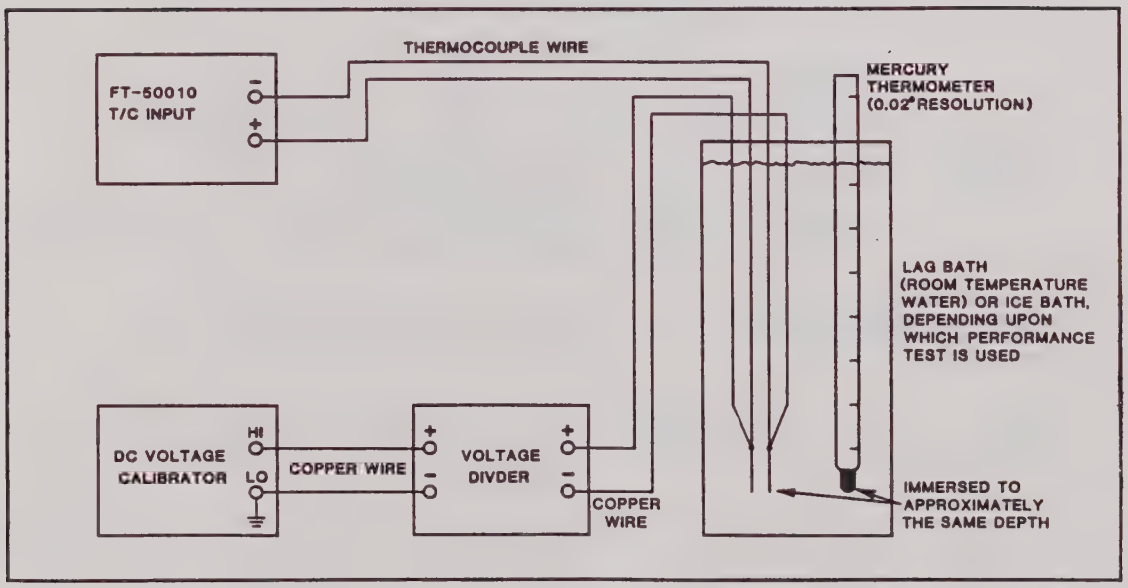
   i. Using Table 4-2, obtain a divider output equal to the first value found under the "Divider output mV" column for the thermocouple type in use.

      NOTE: If a Fluke 720A or 750A is used as the voltage divider a 1 µF capacitor must be placed across its output terminals, otherwise the FT-50010 will indicate an open thermocouple condition. The capacitor is not needed if a Fluke Y2022 is used.

   j. Verify that the FT-50010 temperature display reads the value listed in Table 4-2, within the limits specified (90-day or 1-year as required).

   k. Repeat the above two steps for the remaining values in Table 4-2.

Figure 4-1. Equipment Connections for Ambient or Ice Point Test



THERMOCOUPLE TYPE	DIVIDER OUTPUT, mV	2590FTS DISPLAY (Degree F) 90 DAYS	1 YEAR	2590FTS DISPLAY (Degree C) 90 DAYS	1 YEAR
J	-5.553	-190.0 ± 0.2	-190.0 ± 0.2	-123.3 ± 0.2	-123.3 ± .02
	-2.483	-60.0 ± 0.2	-60.0 ± 0.2	-51.1 ± 0.2	-51.1 ± 0.2
	23.317	800.0 ± 0.2	800.0 ± 0.3	426.7 ± 0.2	426.7 ± 0.2
K	-4.230	-190.0 ± 0.3	-190.0 ± 0.3	-123.3 ± 0.2	-123.3. ± 0.2
	-1.929	-60.0 ± 0.3	-60.0 ± 0.3	-51.1 ± 0.2	-51.1 ± 0.2
	26.975	1200.0 ± 0.5	1200.0 ± 0.5	648.9 ± 0.3	648.9 ± 0.3
	52.939	2400.0 ± 0.7	2400.0 ± 0.7	1315.6 ± 0.4	1315.6 ± 0.4
E	-9.604	-400.0 ± 0.3	-400.0 ± 0.3	-240.0 ± 0.2	-240.0 ± 0.2
	-6.471	-200.0 ± 0.3	-200.0 ± 0.3	-128.9 ± 0.2	-128.9 ± 0.2
	35.562	900.0 ± 0.3	900.0 ± 0.4	482.2 ± 0.2	482.2 ± 0.2
	75.024	1800.0 ± 0.6	1800.0 ± 0.6	982.2 ± 0.3	982.2 ± 0.3
R	1.508	400.0 ± 0.4	400.0 ± 0.4	240.0 ± 0.3	240.0 ± 0.3
	8.141	1500.0 ± 0.6	1500.0 ± 0.7	815.6 ± 0.4	815.6 ± 0.2
	20.275	3100.0 ± 0.9	3100.0 ± 1.0	1704.4 ± 0.6	1704.4 ± 0.6
S	1.962	500.0 ± 0.3	500.0 ± 0.4	260.0 ± 0.2	260.0 ± 0.2
	7.514	1500.0 ± 0.5	1500.0 ± 0.6	815.6 ± 0.3	815.6 ± 0.3
	17.993	3100.0 ± 0.8	3100.0 ± 0.9	1704.4 ± 0.5	1704.4 ± 0.5
T	-6.105	-400.0 ± 0.3	-400.0 ± 0.3	-240.0 ± 0.2	-240.0 ± 0.2
	-4.009	-190.0 ± 0.3	-190.0 ± 0.3	-123.3 ± 0.2	-123.3 ± 0.2
	8.062	350.0 ± 0.3	350.0 ±0.3	176.7 ± 0.2	176.7 ± 0.2
	20.458	740.0 ± 0.4	740.0 ± 0.4	393.3 ± 0.2	393.3 ± 0.2
C	0.522	100.0 ± 0.3	100.0 ± 0.3	37.8 ± 0.2	37.8 ± 0.2
	19.947	2000.0 ± 0.6	2000.0 ± 0.7	1093.3 ± 0.4	1093.3 ± 0.4
	36.539	4100.0 ± 1.1	4100.0 ± 1.2	2260.0 ± 0.6	2260.0 ± 0.6
B	0.891	797.0 ± 0.5	797.0 ± 0.5	425.0 ± 0.3	425.0 ± 0.3
	6.780	2192.0 ± 0.7	2192.0 ± 0.8	1200.0 ± 0.4	1200.0 ± 0.4
	13.690	3290.0 ± 0.9	3290.0 ± 1.0	1810.0 ± 0.5	1810.0 ±0.5

TABLE 4-2 PERFORMANCE TEST VALUES

Temperature in °C. Reference Junction at 0°C

°C	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	0.000	−0.000	−0.000	−0.001	−0.001	−0.001	−0.001	−0.001	−0.002	−0.002	−0.002
10	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.003	−0.003	−0.003
20	−0.003	−0.003	−0.003	−0.003	−0.003	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002
30	−0.002	−0.002	−0.002	−0.002	−0.002	−0.001	−0.001	−0.001	−0.001	−0.001	−0.000
40	−0.000	−0.000	−0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.002
50	0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.006
60	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.010	0.010	0.011	0.011
70	0.011	0.012	0.012	0.013	0.014	0.014	0.015	0.015	0.016	0.017	0.017
80	0.017	0.018	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.025
90	0.025	0.026	0.026	0.027	0.028	0.029	0.030	0.031	0.031	0.032	0.033

Temperature in °F. Reference Junction at 32°F

°F	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	0.006	0.006	0.006	0.006	0.005	0.005	0.005	0.005	0.004	0.004	0.004
10	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002
20	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000
30	0.000	0.000	0.000	−0.000	−0.000	−0.000	−0.001	−0.001	−0.001	−0.001	−0.001
40	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.002	−0.002	−0.002	−0.002	−0.002
50	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002
60	−0.002	−0.002	−0.002	−0.003	−0.003	−0.003	−0.003	−0.003	−0.003	−0.003	−0.003
70	−0.003	−0.003	−0.003	−0.003	−0.003	−0.003	−0.003	−0.002	−0.002	−0.002	−0.002
80	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002
90	−0.002	−0.002	−0.002	−0.002	−0.002	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
100	−0.001	−0.001	−0.001	−0.001	−0.000	−0.000	−0.000	−0.000	0.000	0.000	0.000
110	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002
120	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.004	0.004
130	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.006	0.006	0.006
140	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.009	0.009

TYPE

B

Platinum -6% Rhodium
vs
Platinum -30% Rhodium

Table 4-3. Thermocouple Reference Tables

Temperature in °F. Reference Junction at 32°F

°F	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°
					THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS					
0°	−.234	−.227	−.220	−.213	−.206	−.198	−.191	−.184	−.177	−.169
10°	−.162	−.155	−.148	−.140	−.133	−.126	−.118	−.111	−.104	−.096
20°	−.089	−.082	−.074	−.067	−.060	−.052	−.045	−.037	−.030	−.023
30°	−.015	−.008	.000	.007	.014	.022	.029	.037	.044	.052
40°	.059	.067	.074	.082	.089	.097	.104	.112	.120	.127
50°	.135	.142	.150	.157	.165	.173	.180	.188	.196	.203
60°	.211	.218	.226	.234	.241	.249	.257	.264	.272	.280
70°	.288	.295	.303	.311	.319	.326	.334	.342	.350	.357
80°	.365	.373	.381	.389	.396	.404	.412	.420	.428	.436
90°	.443	.451	.459	.467	.475	.483	.491	.499	.506	.514

TYPE
C*
Tungsten -5% Rhenium
vs
Tungsten -26% Rhenium

*Not an ANSI Standard

Temperature in °C. Reference Junction at 0°C

°C	0	1	2	3	4	5	6	7	8	9	10
						THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS					
−40	−2.254	−2.308	−2.362	−2.416	−2.469	−2.522	−2.575	−2.628	−2.681	−2.734	−2.787
−30	−1.709	−1.764	−1.819	−1.874	−1.929	−1.983	−2.038	−2.092	−2.146	−2.200	−2.254
−20	−1.151	−1.208	−1.264	−1.320	−1.376	−1.432	−1.487	−1.543	−1.599	−1.654	−1.709
−10	−0.581	−0.639	−0.696	−0.754	−0.811	−0.868	−0.925	−0.982	−1.038	−1.095	−1.151
0	0.000	−0.059	−0.117	−0.176	−0.234	−0.292	−0.350	−0.408	−0.466	−0.524	−0.581
0	0.000	0.059	0.118	0.176	0.235	0.295	0.354	0.413	0.472	0.532	0.591
10	0.591	0.651	0.711	0.770	0.830	0.890	0.950	1.011	1.071	1.131	1.192
20	1.192	1.252	1.313	1.373	1.434	1.495	1.556	1.617	1.678	1.739	1.801
30	1.801	1.862	1.924	1.985	2.047	2.109	2.171	2.233	2.295	2.357	2.419
40	2.419	2.482	2.544	2.607	2.669	2.732	2.795	2.858	2.921	2.984	3.047
50	3.047	3.110	3.173	3.237	3.300	3.364	3.428	3.491	3.555	3.619	3.683
60	3.683	3.748	3.812	3.876	3.941	4.005	4.070	4.134	4.199	4.264	4.329
70	4.329	4.394	4.459	4.524	4.590	4.655	4.720	4.786	4.852	4.917	4.983
80	4.983	5.049	5.115	5.181	5.247	5.314	5.380	5.446	5.513	5.579	5.646
90	5.646	5.713	5.780	5.846	5.913	5.981	6.048	6.115	6.182	6.250	6.317

TYPE
E
Nickel - Chromium
vs
Copper - Nickel

Table 4-3. Thermocouple Reference Tables (cont.)

Temperature in °F. Reference Junction at 32°F

°F	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	−1.026	−0.994	−0.963	−0.931	−0.900	−0.868	−0.836	−0.805	−0.773	−0.741	−0.709
10	−0.709	−0.677	−0.645	−0.613	−0.581	−0.549	−0.517	−0.485	−0.453	−0.421	−0.389
20	−0.389	−0.357	−0.324	−0.292	−0.260	−0.227	−0.195	−0.163	−0.130	−0.098	−0.065
30	−0.065	−0.033	0.000	0.033	0.065	0.098	0.131	0.163	0.196	0.229	0.262
40	0.262	0.295	0.327	0.360	0.393	0.426	0.459	0.492	0.525	0.558	0.591
50	0.591	0.624	0.658	0.691	0.724	0.757	0.790	0.824	0.857	0.890	0.924
60	0.924	0.957	0.990	1.024	1.057	1.091	1.124	1.158	1.192	1.225	1.259
70	1.259	1.292	1.326	1.360	1.394	1.427	1.461	1.495	1.529	1.563	1.597
80	1.597	1.631	1.665	1.699	1.733	1.767	1.801	1.835	1.869	1.903	1.937
90	1.937	1.972	2.006	2.040	2.075	2.109	2.143	2.178	2.212	2.247	2.281
100	2.281	2.316	2.350	2.385	2.419	2.454	2.489	2.523	2.558	2.593	2.627
110	2.627	2.662	2.697	2.732	2.767	2.802	2.837	2.872	2.907	2.942	2.977
120	2.977	3.012	3.047	3.082	3.117	3.152	3.187	3.223	3.258	3.293	3.329
130	3.329	3.364	3.399	3.435	3.470	3.506	3.541	3.577	3.612	3.648	3.683
140	3.683	3.719	3.755	3.790	3.826	3.862	3.898	3.933	3.969	4.005	4.041

TYPE E
Nickel - Chromium vs Copper - Nickel

Temperature in °C. Reference Junction at 0°C

°C	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
−40	−1.960	−2.008	−2.055	−2.102	−2.150	−2.197	−2.244	−2.291	−2.338	−2.384	−2.431
−30	−1.481	−1.530	−1.578	−1.626	−1.674	−1.722	−1.770	−1.818	−1.865	−1.913	−1.960
−20	−0.995	−1.044	−1.093	−1.141	−1.190	−1.239	−1.288	−1.336	−1.385	−1.433	−1.481
−10	−0.501	−0.550	−0.600	−0.650	−0.699	−0.748	−0.798	−0.847	−0.896	−0.945	−0.995
0	0.000	−0.050	−0.101	−0.151	−0.201	−0.251	−0.301	−0.351	−0.401	−0.451	−0.501
0	0.000	0.050	0.101	0.151	0.202	0.253	0.303	0.354	0.405	0.456	0.507
10	0.507	0.558	0.609	0.660	0.711	0.762	0.813	0.865	0.916	0.967	1.019
20	1.019	1.070	1.122	1.174	1.225	1.277	1.329	1.381	1.432	1.484	1.536
30	1.536	1.588	1.640	1.693	1.745	1.797	1.849	1.901	1.954	2.006	2.058
40	2.058	2.111	2.163	2.216	2.268	2.321	2.374	2.426	2.479	2.532	2.585
50	2.585	2.638	2.691	2.743	2.796	2.849	2.902	2.956	3.009	3.062	3.115
60	3.115	3.168	3.221	3.275	3.328	3.381	3.435	3.488	3.542	3.595	3.649
70	3.649	3.702	3.756	3.809	3.863	3.917	3.971	4.024	4.078	4.132	4.186
80	4.186	4.239	4.293	4.347	4.401	4.455	4.509	4.563	4.617	4.671	4.725
90	4.725	4.780	4.834	4.888	4.942	4.996	5.050	5.105	5.159	5.213	5.268

Temperature in °F. Reference Junction at 32°F

°F	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	−0.885	−0.858	−0.831	−0.803	−0.776	−0.748	−0.721	−0.694	−0.666	−0.639	−0.611
10	−0.611	−0.583	−0.556	−0.528	−0.501	−0.473	−0.445	−0.418	−0.390	−0.362	−0.334
20	−0.334	−0.307	−0.279	−0.251	−0.223	−0.195	−0.168	−0.140	−0.112	−0.084	−0.056
30	−0.056	−0.028	0.000	0.028	0.056	0.084	0.112	0.140	0.168	0.196	0.224
40	0.224	0.253	0.281	0.309	0.337	0.365	0.394	0.422	0.450	0.478	0.507
50	0.507	0.535	0.563	0.592	0.620	0.648	0.677	0.705	0.734	0.762	0.791
60	0.791	0.819	0.848	0.876	0.905	0.933	0.962	0.990	1.019	1.048	1.076
70	1.076	1.105	1.134	1.162	1.191	1.220	1.248	1.277	1.306	1.335	1.363
80	1.363	1.392	1.421	1.450	1.479	1.507	1.536	1.565	1.594	1.623	1.652
90	1.652	1.681	1.710	1.739	1.768	1.797	1.826	1.855	1.884	1.913	1.942
100	1.942	1.971	2.000	2.029	2.058	2.088	2.117	2.146	2.175	2.204	2.233
110	2.233	2.263	2.292	2.321	2.350	2.380	2.409	2.438	2.467	2.497	2.526
120	2.526	2.555	2.585	2.614	2.644	2.673	2.702	2.732	2.761	2.791	2.820
130	2.820	2.849	2.879	2.908	2.938	2.967	2.997	3.026	3.056	3.085	3.115
140	3.115	3.145	3.174	3.204	3.233	3.263	3.293	3.322	3.352	3.381	3.411

TYPE J
Iron vs Copper - Nickel

Table 4-3. Thermocouple Reference Tables (cont.)

Temperature in °C. Reference Junction at 0°C

°C	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
−40	−1.527	−1.563	−1.600	−1.636	−1.673	−1.709	−1.745	−1.781	−1.817	−1.853	−1.889
−30	−1.156	−1.193	−1.231	−1.268	−1.305	−1.342	−1.379	−1.416	−1.453	−1.490	−1.527
−20	−0.777	−0.816	−0.854	−0.892	−0.930	−0.968	−1.005	−1.043	−1.081	−1.118	−1.156
−10	−0.392	−0.431	−0.469	−0.508	−0.547	−0.585	−0.624	−0.662	−0.701	−0.739	−0.777
0	0.000	−0.039	−0.079	−0.118	−0.157	−0.197	−0.236	−0.275	−0.314	−0.353	−0.392
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.162	1.203
30	1.203	1.244	1.285	1.325	1.366	1.407	1.448	1.489	1.529	1.570	1.611
40	1.611	1.652	1.693	1.734	1.776	1.817	1.858	1.899	1.940	1.981	2.022
50	2.022	2.064	2.105	2.146	2.188	2.229	2.270	2.312	2.353	2.394	2.436
60	2.436	2.477	2.519	2.560	2.601	2.643	2.684	2.726	2.767	2.809	2.850
70	2.850	2.892	2.933	2.975	3.016	3.058	3.100	3.141	3.183	3.224	3.266
80	3.266	3.307	3.349	3.390	3.432	3.473	3.515	3.556	3.598	3.639	3.681
90	3.681	3.722	3.764	3.805	3.847	3.888	3.930	3.971	4.012	4.054	4.095

Temperature in °F. Reference Junction at 32°F

°F	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	−0.692	−0.671	−0.650	−0.628	−0.607	−0.585	−0.564	−0.543	−0.521	−0.500	−0.478
10	−0.478	−0.457	−0.435	−0.413	−0.392	−0.370	−0.349	−0.327	−0.305	−0.284	−0.262
20	−0.262	−0.240	−0.218	−0.197	−0.175	−0.153	−0.131	−0.109	−0.088	−0.066	−0.044
30	−0.044	−0.022	0.000	0.022	0.044	0.066	0.088	0.110	0.132	0.154	0.176
40	0.176	0.198	0.220	0.242	0.264	0.286	0.308	0.331	0.353	0.375	0.397
50	0.397	0.419	0.441	0.464	0.486	0.508	0.530	0.553	0.575	0.597	0.619
60	0.619	0.642	0.664	0.686	0.709	0.731	0.753	0.776	0.798	0.821	0.843
70	0.843	0.865	0.888	0.910	0.933	0.955	0.978	1.000	1.023	1.045	1.068
80	1.068	1.090	1.113	1.135	1.158	1.181	1.203	1.226	1.248	1.271	1.294
90	1.294	1.316	1.339	1.362	1.384	1.407	1.430	1.452	1.475	1.498	1.520
100	1.520	1.543	1.566	1.589	1.611	1.634	1.657	1.680	1.703	1.725	1.748
110	1.748	1.771	1.794	1.817	1.839	1.862	1.885	1.908	1.931	1.954	1.977
120	1.977	2.000	2.022	2.045	2.068	2.091	2.114	2.137	2.160	2.183	2.206
130	2.206	2.229	2.252	2.275	2.298	2.321	2.344	2.367	2.390	2.413	2.436
140	2.436	2.459	2.482	2.505	2.528	2.551	2.574	2.597	2.620	2.643	2.666

TYPE

K

Nickel - Chromium
vs
Nickel - Aluminum

Table 4-3. Thermocouple Reference Tables (cont.)

Table 4-3. Thermocouple Reference Tables (cont.)

TYPE S
Platinum vs Platinum -10% Rhodium

Temperature in °F. Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

°F	0	1	2	3	4	5	6	7	8	9	10
0	−0.092	−0.089	−0.086	−0.084	−0.081	−0.078	−0.075	−0.073	−0.070	−0.067	−0.064
10	−0.064	−0.061	−0.058	−0.056	−0.053	−0.050	−0.047	−0.044	−0.041	−0.038	−0.035
20	−0.035	−0.033	−0.030	−0.027	−0.024	−0.021	−0.018	−0.015	−0.012	−0.009	−0.006
30	−0.006	−0.003	0.000	0.003	0.006	0.009	0.012	0.015	0.018	0.021	0.024
40	0.024	0.027	0.030	0.033	0.037	0.040	0.043	0.046	0.049	0.052	0.055
50	0.055	0.058	0.062	0.065	0.068	0.071	0.074	0.077	0.081	0.084	0.087
60	0.087	0.090	0.093	0.097	0.100	0.103	0.106	0.110	0.113	0.116	0.119
70	0.119	0.123	0.126	0.129	0.133	0.136	0.139	0.142	0.146	0.149	0.152
80	0.152	0.156	0.159	0.163	0.166	0.169	0.173	0.176	0.179	0.183	0.186
90	0.186	0.190	0.193	0.197	0.200	0.203	0.207	0.210	0.214	0.217	0.221
100	0.221	0.224	0.228	0.231	0.235	0.238	0.242	0.245	0.249	0.252	0.256
110	0.256	0.259	0.263	0.266	0.270	0.274	0.277	0.281	0.284	0.288	0.291
120	0.291	0.295	0.299	0.302	0.306	0.309	0.313	0.317	0.320	0.324	0.328
130	0.328	0.331	0.335	0.339	0.342	0.346	0.350	0.353	0.357	0.361	0.365
140	0.365	0.368	0.372	0.376	0.379	0.383	0.387	0.391	0.394	0.398	0.402

TYPE T
Copper vs Copper - Nickel

Temperature in °C. Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

°C	0	1	2	3	4	5	6	7	8	9	10
−40	−1.475	−1.510	−1.544	−1.579	−1.614	−1.648	−1.682	−1.717	−1.751	−1.785	−1.819
−30	−1.121	−1.157	−1.192	−1.228	−1.263	−1.299	−1.334	−1.370	−1.405	−1.440	−1.475
−20	0.757	0.794	0.830	0.867	0.903	0.940	0.976	1.013	1.049	1.085	1.121
−10	0.383	0.421	0.458	0.496	0.534	0.571	0.608	0.646	0.683	0.720	0.757
0	0.000	0.039	0.077	0.116	0.154	0.193	0.231	0.269	0.307	0.345	0.383
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.351	0.391
10	0.391	0.430	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749	0.789
20	0.789	0.830	0.870	0.911	0.951	0.992	1.032	1.073	1.114	1.155	1.196
30	1.196	1.237	1.279	1.320	1.361	1.403	1.444	1.486	1.528	1.569	1.611
40	1.611	1.633	1.695	1.738	1.780	1.822	1.865	1.907	1.950	1.992	2.035
50	2.035	2.078	2.121	2.164	2.207	2.250	2.294	2.337	2.380	2.424	2.467
60	2.467	2.511	2.555	2.599	2.643	2.687	2.731	2.775	2.819	2.864	2.908
70	2.908	2.953	2.997	3.042	3.087	3.131	3.176	3.221	3.266	3.312	3.357
80	3.357	3.402	3.447	3.493	3.538	3.584	3.630	3.676	3.721	3.767	3.813
90	3.813	3.859	3.906	3.952	3.998	4.044	4.091	4.137	4.184	4.231	4.277

Temperature in °F. Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

°F	0	1	2	3	4	5	6	7	8	9	10
0	−0.674	−0.654	−0.633	−0.613	−0.592	−0.571	−0.550	−0.529	−0.509	−0.488	−0.467
10	−0.467	−0.446	−0.425	−0.404	−0.383	−0.362	−0.341	−0.320	−0.299	−0.277	−0.256
20	−0.256	−0.235	−0.214	−0.193	−0.171	−0.150	−0.129	−0.107	−0.086	−0.064	−0.043
30	−0.043	−0.022	0.000	0.022	0.043	0.065	0.086	0.108	0.130	0.151	0.173
40	0.173	0.195	0.216	0.238	0.260	0.282	0.303	0.325	0.347	0.369	0.391
50	0.391	0.413	0.435	0.457	0.479	0.501	0.523	0.545	0.567	0.589	0.611
60	0.611	0.634	0.656	0.678	0.600	0.722	0.745	0.767	0.789	0.812	0.834
70	0.834	0.857	0.879	0.902	0.924	0.947	0.969	0.992	1.014	1.037	1.060
80	1.060	1.082	1.105	1.128	1.151	1.173	1.196	1.219	1.242	1.265	1.288
90	1.288	1.311	1.334	1.357	1.380	1.403	1.426	1.449	1.472	1.495	1.518
100	1.518	1.542	1.565	1.588	1.611	1.635	1.658	1.681	1.705	1.728	1.752
110	1.752	1.775	1.799	1.822	1.846	1.869	1.893	1.917	1.940	1.964	1.988
120	1.988	2.011	2.035	2.059	2.083	2.107	2.131	2.154	2.178	2.202	2.226
130	2.226	2.250	2.274	2.298	2.322	2.347	2.371	2.395	2.419	2.443	2.467
140	2.467	2.492	2.516	2.540	2.565	2.589	2.613	2.638	2.662	2.687	2.711

Table 4-3. Thermocouple Reference Tables (cont.)

Temperature in °C. Reference Junction at 0°C

°C	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	0.000	0.005	0.011	0.016	0.021	0.027	0.032	0.038	0.043	0.049	0.054
10	0.054	0.060	0.065	0.071	0.077	0.082	0.088	0.094	0.100	0.105	0.111
20	0.111	0.117	0.123	0.129	0.135	0.141	0.147	0.152	0.158	0.165	0.171
30	0.171	0.177	0.183	0.189	0.195	0.201	0.207	0.214	0.220	0.226	0.232
40	0.232	0.239	0.245	0.251	0.258	0.264	0.271	0.277	0.283	0.290	0.296
50	0.296	0.303	0.310	0.316	0.323	0.329	0.336	0.343	0.349	0.356	0.363
60	0.363	0.369	0.376	0.383	0.390	0.397	0.403	0.410	0.417	0.424	0.431
70	0.431	0.438	0.445	0.452	0.459	0.466	0.473	0.480	0.487	0.494	0.501
80	0.501	0.508	0.515	0.523	0.530	0.537	0.544	0.552	0.559	0.566	0.573
90	0.573	0.581	0.588	0.595	0.603	0.610	0.617	0.625	0.632	0.640	0.647

TYPE
R
Platinum
vs
Platinum -13% Rhodium

Temperature in °F. Reference Junction at 32°F

°F	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	−0.089	−0.087	−0.084	−0.082	−0.079	−0.076	−0.073	−0.071	−0.068	−0.065	−0.063
10	−0.063	−0.060	−0.057	−0.054	−0.051	−0.049	−0.046	−0.043	−0.040	−0.037	−0.035
20	−0.035	−0.032	−0.029	−0.026	−0.023	−0.020	−0.017	−0.015	−0.012	−0.009	−0.006
30	−0.006	−0.003	0.000	0.003	0.006	0.009	0.012	0.015	0.018	0.021	0.024
40	0.024	0.027	0.030	0.033	0.036	0.039	0.042	0.045	0.048	0.051	0.054
50	0.054	0.057	0.060	0.064	0.067	0.070	0.073	0.076	0.079	0.082	0.086
60	0.086	0.089	0.092	0.095	0.098	0.101	0.105	0.108	0.111	0.114	0.118
70	0.118	0.121	0.124	0.127	0.131	0.134	0.137	0.141	0.144	0.147	0.150
80	0.150	0.154	0.157	0.161	0.164	0.167	0.171	0.174	0.177	0.181	0.184
90	0.184	0.188	0.191	0.194	0.198	0.201	0.205	0.208	0.212	0.215	0.218
100	0.218	0.222	0.225	0.229	0.232	0.236	0.239	0.243	0.246	0.250	0.253
110	0.253	0.257	0.261	0.264	0.268	0.271	0.275	0.278	0.282	0.286	0.289
120	0.289	0.293	0.296	0.300	0.304	0.307	0.311	0.315	0.318	0.322	0.326
130	0.326	0.329	0.333	0.337	0.340	0.344	0.348	0.351	0.355	0.359	0.363
140	0.363	0.366	0.370	0.374	0.378	0.381	0.385	0.389	0.393	0.397	0.400

Temperature in °C. Reference Junction at 0°C

°C	0	1	2	3	4	5	6	7	8	9	10
	THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS										
0	0.000	0.005	0.011	0.016	0.022	0.027	0.033	0.038	0.044	0.050	0.055
10	0.055	0.061	0.067	0.072	0.078	0.084	0.090	0.095	0.101	0.107	0.113
20	0.113	0.119	0.125	0.131	0.137	0.142	0.148	0.154	0.161	0.167	0.173
30	0.173	0.179	0.185	0.191	0.197	0.203	0.210	0.216	0.222	0.228	0.235
40	0.235	0.241	0.247	0.254	0.260	0.266	0.273	0.279	0.286	0.292	0.299
50	0.299	0.305	0.312	0.318	0.325	0.331	0.338	0.345	0.351	0.358	0.365
60	0.365	0.371	0.378	0.385	0.391	0.398	0.405	0.412	0.419	0.425	0.432
70	0.432	0.439	0.446	0.453	0.460	0.467	0.474	0.481	0.488	0.495	0.502
80	0.502	0.509	0.516	0.523	0.530	0.537	0.544	0.551	0.558	0.566	0.573
90	0.573	0.580	0.587	0.594	0.602	0.609	0.616	0.623	0.631	0.638	0.645
100	0.645	0.653	0.660	0.667	0.675	0.682	0.690	0.697	0.704	0.712	0.719
110	0.719	0.727	0.734	0.742	0.749	0.757	0.764	0.772	0.780	0.787	0.795
120	0.795	0.802	0.810	0.818	0.825	0.833	0.841	0.848	0.856	0.864	0.872
130	0.872	0.879	0.887	0.895	0.903	0.910	0.918	0.926	0.934	0.942	0.950
140	0.950	0.957	0.965	0.973	0.981	0.989	0.997	1.005	1.013	1.021	1.029

TYPE
S
Platinum
vs
Platinum -10% Rhodium

4-22. Thermocouple Calibration Output Verification

This procedure checks the range of the CALIBRATION OUTPUT section (thermocouple simulator) of the temperature section of the FT-50010.

1. Connect the thermocouple input to a 5-1/2 digit multimeter as shown in Figure 4-2. Set the voltmeter to volts dc, 200 mV range.

2. Press the correct button to select the FT-50010 T/C input that is connected to the multimeter.

3. Depress the Calibration Output pushbutton to enable CALIBRATION OUTPUT; select K-type thermocouple, °F.

4. Rotate the CAL OUTPUT Fine and Coarse controls fully counter-clockwise. Verify a voltmeter reading of -10 mV or more negative and a UUT temperature display of -0.L °F.

5. Verify that the thermometer display varies between -10 mV and +90 mV as the Fine and Coarse controls are rotated clockwise.

6. Rotate the CAL OUTPUT Fine and Coarse controls fully clockwise. Verify a voltmeter reading of at least +90 mV and a UUT temperature display of "0.L °F".

7. Release THE CALIBRATION OUT pushbutton to the out position to enable EXTERNAL IN. Verify that the thermometer displays "O.C".

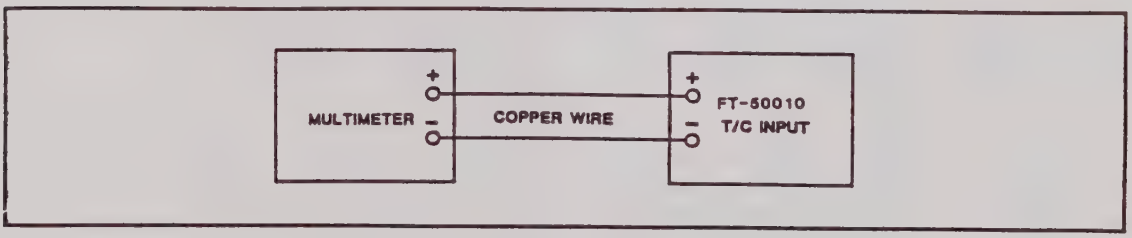


Figure 4-2. Calibrator Output Verification

4-23. Multimeter Verification

4-24. Use the following procedures to verify proper operation of the FT-50010 multimeter section.

4-25. MULTIMETER DISPLAY TEST

1. Turn the FT-50010 power on.
2. In the multimeter, select kΩ function, 2000 kΩ range.
3. In the multimeter input select section, press EXT INPUT.
4. Verify that the multimeter displays an overrange indication (a "1" followed by three blank digits).
5. Select the DC volts function.
6. Verify that the multimeter displays "000".
7. Place a short across the V/kΩ/S and COM external input terminals.
8. Select each range in sequence starting with the 200 mV range. Verify that the decimal point location agrees with Table 4-4 (and that the reading is 0 ± 1 count).
9. Connect the HI output of the meter calibrator to the multimeter external input COM. Connect the LO output of the calibrator to the V/kΩ/S external input. In the multimeter section, select the 20V range.
10. Program the calibrator for an output of 11.11V. Verify that the display reads -11.11 (adjust the least significant digit of the calibrator if necessary).
11. Program the calibrator for outputs of 12.22V, 16.66V, and 18.88V. Verify that each output is properly displayed, and that there are no missing or shorted segments or ghosting (ghosting is when elements are barely visible when they are not supposed to be visible at all).

RANGE	LCD DISPLAY
200mV	00.0
2V	.000
20V	0.00
200V	00.0
1000V	000

Table 4-4. Decimal Point Location (Multimeter)

4-26. RESISTANCE/CONDUCTANCE TEST

1. Connect a short across the V/kΩ/S ext. input terminals.
2. In the multimeter, select kΩ function, 200Ω range.
3. Verify a multimeter reading of 00.0 to 00.4Ω.
4. Remove the short from the multimeter external input.
5. Select the conductance function, 200 nS range.
6. Verify a multimeter reading of 00.0 to 00.3.
7. Connect the meter calibrator to the FT-50010 multimeter V/kΩ/S and COM external inputs.
8. Referring to Table 4-5, select the proper multimeter range and calibrator output and verify proper display for each step.
9. 200Ω range accuracy. To determine the error due to lead resistance and calibrator internal resistance, set the 5100B to output 1Ω and note the reading on the A21-50 multimeter. Using the edit controls on the 5100B adjust the 5100B to indicate the same reading as the A21-50. Press the 'NEW REF' button on the 5100B. Set the 5100B to 100Ω output. Adjust the edit control to match the 5100B display to the A21-50 display. The percentage error indicated by the 5100B should be between +0.3% and -0.3%. Continue with the verification steps listed below.

STEP	RANGE	CALIBRATOR OUTPUT	DISPLAY READING
1	200Ω	100Ω	99.7 to 100.3
2	2 kΩ	1 kΩ	.997 to 1.003
3	20 kΩ	10 kΩ	9.97 to 10.03
4	200 kΩ	100 kΩ	99.7 to 100.3
5	2000 kΩ	1 MΩ	994 to 1006
6	20 MΩ	10 MΩ	9.94 to 10.06
7	2 mS	1 kΩ	.997 to 1.003
8	20 µS	100 kΩ	9.97 to 10.03
9	200 nS	10 MΩ	98.0 to 102.0

Table 4-5. Resistance/Conductance Test

4-27. DC VOLTAGE TEST

CAUTION

TO AVOID EXCEEDING THE INSTRUMENT'S COMMON MODE LIMITS, BE CAREFUL TO MAKE THE INPUT CONNECTION AS DESCRIBED BELOW.

1. Connect the HI output of the meter calibrator to the V/kΩ/S multimeter input. Connect the calibrator LO output to the multimeter COM input.

2. In the multimeter section, select the DC Volts function.

3. Referring to Table 4-6, select the proper multimeter range and meter calibrator output and verify proper display for each step.

STEP	RANGE	CALIBRATOR OUTPUT	DISPLAY READING
1	200 mV	+190.0 mV	189.7 to 190.3
2	2V	+1.900V	1.897 to 1.903
3	20V	+19.00V	18.97 to 19.03
4	20V	-19.00V	-18.97 to -19.03
5	200V	+190.0V	189.7 to 190.3
6	1000V	+1000V	998 to 1002

Table 4-6. DC Voltage Test

4. Set the calibrator output to zero volts and standby.

4-28. AC VOLTAGE TEST

CAUTION

TO AVOID EXCEEDING THE INSTRUMENT'S COMMON MODE LIMITS, BE CAREFUL TO MAKE THE INPUT CONNECTION AS DESCRIBED BELOW.

1. Connect the HI output of the meter calibrator system to the V/kΩ/S multimeter external input. Connect the LO output of the calibrator to multimeter external input COM.

2. In the FT-50010 multimeter, select the AC and V functions.

3. Referring to Table 4-7, select the multimeter range and calibrator output, and verify proper display for each step.

STEP	RANGE	CALIBRATOR LEVEL	CALIBRATOR FREQ	DISPLAY READING
1	200 mV	190.0 mV	100 Hz	188.3 to 191.7
2	200 mV	10.0 mV	100 Hz	9.7 to 10.3
3	2V	1.900V	100 Hz	1.883 to 1.917
4	20V	19.00V	100 Hz	18.81 to 19.17
5	200V	190.0V	100 Hz	188.3 to 191.7
6	750V	750V	100 Hz	742 to 758
7	750V	250V	1 kHz	246 to 254
8	20V	1.00V	10 kHz	.97 to 1.03
9	20V	19.00V	10 kHz	18.79 to 19.21
10	200V	110.0V	10 kHz	108.8 to 111.2
11	20V	19.00V	20 kHz	18.79 to 19.21

Table 4-7. AC Voltage Test

4. Set the calibrator output for zero volts and standby.

4-29. DC CURRENT TEST

1. Connect the HI output of the meter calibrator to the mA external input of the multimeter. Connect the calibrator LO output to the multimeter external input COM.

2. In the FT-50010 multimeter section, select the DC mA function.

3. Referring to Table 4-8, select the proper multimeter range and calibrator output, and verify proper display for each step.

STEP	RANGE	CALIBRATOR OUTPUT	DISPLAY READING
1	200 µA	190.0 µA	189.3 to 190.7
2	2 mA	1.900 mA	1.893 to 1.907
3	20 mA	19.00 mA	18.93 to 19.07
4	200 mA	190.0 mA	189.3 to 190.7
5	2000 mA	1900 mA	1893 to 1907

Table 4-8. DC mA Test

4. Set the calibrator output for zero output and standby.

4-30. AC CURRENT TEST

1. Connect the HI output of the meter calibrator to the mA external input of the multimeter. Connect the calibrator LO output to the multimeter external input COM.

2. In the FT-50010 multimeter section, select the AC mA function, 200 µA range.

3. Program the multimeter calibrator for an output level of 190.0 µA at a frequency of 1 kHz.

4. Verify a multimeter display between 187.9 and 192.1 µA.

5. Program calibrator for zero output and disconnect from FT-50010.

4-31. Frequency Counter Verification

4-32. Use the following procedure to verify operation of the FT-50010 frequency counter section.

1. Select EXT FREQ 1 in the FT-50010 Audio Frequency Section.
2. Connect the output of the signal generator (Fluke 6011 or equivalent) to the EXT FREQ 1 input connector on the FT-50010.
3. Select EXT FREQ 1 in the Multimeter Input Select section.
4. Select AC Volts, 200 mV range in the Multimeter section.
5. Set the counter Trigger Level Adjust control fully counterclockwise.
6. Adjust the signal generator for an output of 25 kHz. Using the FT-50010 multimeter as a reference, adjust the output amplitude to 75 mV ± 5 mV.
7. Verify a frequency counter reading of 25000 Hz ± 2 Hz.
8. Verify that the counter stops counting the input signal as the Trigger Level Adjust is rotated clockwise. Return the Trigger Level Adjust to its fully counter clockwise position.
9. Repeat steps 6 and 7 for frequencies of 50 kHz and 99 kHz.
10. Adjust the signal generator for an output frequency of 101 kHz. Verify that the FT-50010 frequency counter indicates an overflow condition (0.0.0.0.0 Hz).
11. Select External Frequency No. 2 in the Audio Frequency and Multimeter Input Select sections.
12. Connect the signal generator output to the External Frequency No. 2 input. Repeat steps 5 through 9 and verify proper FT-50010 counter readings.

4-33. Frequency Source Verification

4-34. Use the following procedure to verify operation of both frequency source sections of the FT-50010.

1. Select FREQ Source 1 in the Audio Frequency Signal Source Select section. (These steps are later repeated for Frequency Source 2).
2. Connect a 600Ω, ± 12Ω, 4W resistive load across the output of the A21-50 frequency source that is to be tested.
3. Sine Wave: Select the sine function.
4. AC Amplitude:
   a. Press the multimeter input switch for the frequency source under test (FREQ 1 or FREQ 2), and select AC Volts, 200V range.
   b. To measure the ac amplitude under worst-case loading, pull out the DC Offset control and turn it fully counter clockwise.
   c. Verify that the frequency source can be adjusted for an amplitude of 20.0V rms (+0.2, -0.0V rms) and a frequency of at least 15000 Hz. Leave the source at these settings for the DC Offset test.
   d. Connect a oscilloscope to the output and check that the waveform is clean (no clipping or rounding at the peaks, no visible distortion).

5. DC Offset:

   a. In the multimeter section, select DC Volts, 200V range.

   b. With the DC Offset control pulled out, turn it counter clockwise to produce a UUT multimeter display of -18.0V or more negative. Be sure you are performing this test with the AC amplitude at 20.0V rms, 15 kHz (as set in step 4.c.), for worst-case loading.

   c. Rotate the DC Offset control fully clockwise. Verify a UUT multimeter display of +18.0V or greater.

   d. Short the output for 10 seconds (maximum of 1 minute). Remove short and verify both AC output and DC Offset return to normal values.

6. Square Wave: Repeat steps 4 and 5 with the square wave selected. (When observing the square wave in step 4, note that it is expected to have rounded leading edges at 15 kHz.

7. Repeat steps 3-6 but with the frequency source adjusted to 50 Hz in steps 4.c. and 5.b. (and same amplitude as before).

8. With the square wave selected and the DC Offset defeated (pushed in), set the frequency to 40 Hz (and the same 20V rms amplitude). Connect an oscilloscope and verify the duty cycle is 50% ± 5%.

9. Select Frequency Source 2 and repeat steps 2-8 for this other source.

4-35. DC Voltage Source Verification

4-36. Use the following procedure to verify proper operation of both of the FT-50010 DC voltage source (DC VOLTS OUT) sections. Note: The DC voltage sources do not require calibration.

1. Connect a 25Ω, 5%, 10W resistor (JF P/N 733469) to the DC VOLTS SOURCE output and press the multimeter input select switch for DC VOLTS OUT 1.

2. 1V Range:

   a. In No. 1 DC VOLTS OUT section, select the 1V range.

   b. In the multimeter, select DC volts, 2V range.

   c. Verify that the Coarse and Fine controls can adjust the DC VOLTS OUT to > 1V max. and ≤ 0.0 mV min.

3. 10V Range:

   a. In No. 1 DC VOLTS OUT section, select the 10V range.

   b. In the multimeter, select the 20V range.

   c. Verify the controls can adjust the DC VOLTS OUT to > 10V max. and ≤ 0.0V min.

4. Short-Circuit Current:

   a. Set the DC VOLTS OUT to 5V or greater.

   b. Measure the short-circuit current from the DC VOLTS OUT with the UUT multimeter by connecting the external mA input terminals across the load (HI of DC VOLTS OUT to mA terminal of multimeter, and LO to COM).

   c. In the multimeter, select DC mA, 2000 mA range.

   d. Verify a multimeter reading of less than 600 mA.

5. Repeat steps 1-4 for No. 2 DC VOLTS OUT

4-37. DC Current Source Verification

4-38. Use the following procedure to verify proper operation of the FT-50010 current source (DC mA OUT) section. Note: The current source requires no calibration.

1. Connect a 280Ω (± 3Ω), 8W resistor across the DC mA OUT outputs. (This high wattage is necessary to keep the temperature coefficient low, so the resistor value will not change appreciably as it heats up.)

2. 1 mA Range:

   a. Select the 1 mA range in the DC mA OUT section.

   b. Select DC mA OUT in the multimeter input select section.

   c. In the FT-50010 multimeter, select DC mA, 2 mA range.

   d. Verify that the current source can be adjusted for an output of at least 1.000 mA.

3. 100 mA Range:

   a. Select the 200 mA range in the multimeter section.

   b. Select the 100 mA range in the DC mA OUT section.

   c. Verify that the current source can be adjusted for an output greater than 100.0 mA.

   NOTE: If the output cannot be adjusted to at least 100 mA, verify that the load resistor is within tolerance (277 to 283Ω) when it is warm.

4. Short-Circuit Regulation:

   a. Adjust the DC mA Out for 100.0 mA (+0.2, -0.0 mA).

   b. Connect a short across the load resistor. Verify that the reading does not change by more than 0.2 mA.

4-39. Relay Timer Verification

4-40. Use the following procedure to verify proper operation of the FT-50010 relay timer section. (The factory uses a Time-Delay Relay test fixture to verify proper operation.)

1. Construct a relay timer test cable as follows:

   a. Terminate one end of each of four 20 inch lengths of No 24 stranded wire to one of the four terminals of a relay timer mating connector (JF P/N 643791).

   b. Connect the open end of the wire from pin "A" of the mating connector to the (+) side of a dual banana connector.

   c. Connect the open end of the wire from pin "D" to the common (-) side of the dual banana connector.

   d. Connect a 620Ω, 4W resistor across the pins of this banana connector.

   e. Connect the remaining two wires (from "B" & "C") across a normally open SPST, momentary pushbutton switch.

2. Connect the timer test cable to the panel connector in the FT-50010 relay timer section.

3. Connect the dual banana connector between the V/kΩ and common terminals in the multimeter external input section.

4. Select EXT input in the multimeter input select section.

5. Select the DC volts function, 200V range in the multimeter section.

6. Select the DELAY PICK UP mode in the relay timer section.

7. Depress the ARM pushbutton.

8. Depress the START pushbutton. Verify that the FT-50010 multimeter reads between 20 and 34V dc. Verify that the timer starts to count.

9. Depress the pushbutton on the timer test cable. Verify that the timer stops counting while the button is depressed.

10. Release ARM and START pushbuttons.

11. Select the DELAY DROP OUT mode.

12. Depress the ARM switch. Verify that the FT-50010 multimeter reads between 20 and 34V dc.

13. Depress the pushbutton on the timer test cable and hold it in.

14. Depress the START pushbutton. Verify that the multimeter reads 00.0V dc. Verify that the timer starts to count.

15. Release the pushbutton on the timer test cable. Verify that the timer stops counting.

16. Release the START pushbutton. Verify that the timer reads "000.0".

4-41. CALIBRATION

4-42. The following procedures should be used for calibrating the FT-50010. Most of these calibration tests are performed with the instrument removed from the carrying case so that the calibration adjustments are accessible. Make sure, however, that the bottom shield is properly installed on the bottom of the main circuit board (do not fasten the top of the shield to the display circuit board). All tests should be conducted with an ambient temperature of 25°C ± 2°C.

4-43. Refer to Table 4-1 for the list of required equipment. Figure 4-3 shows the outline of the main circuit board including test point locations.

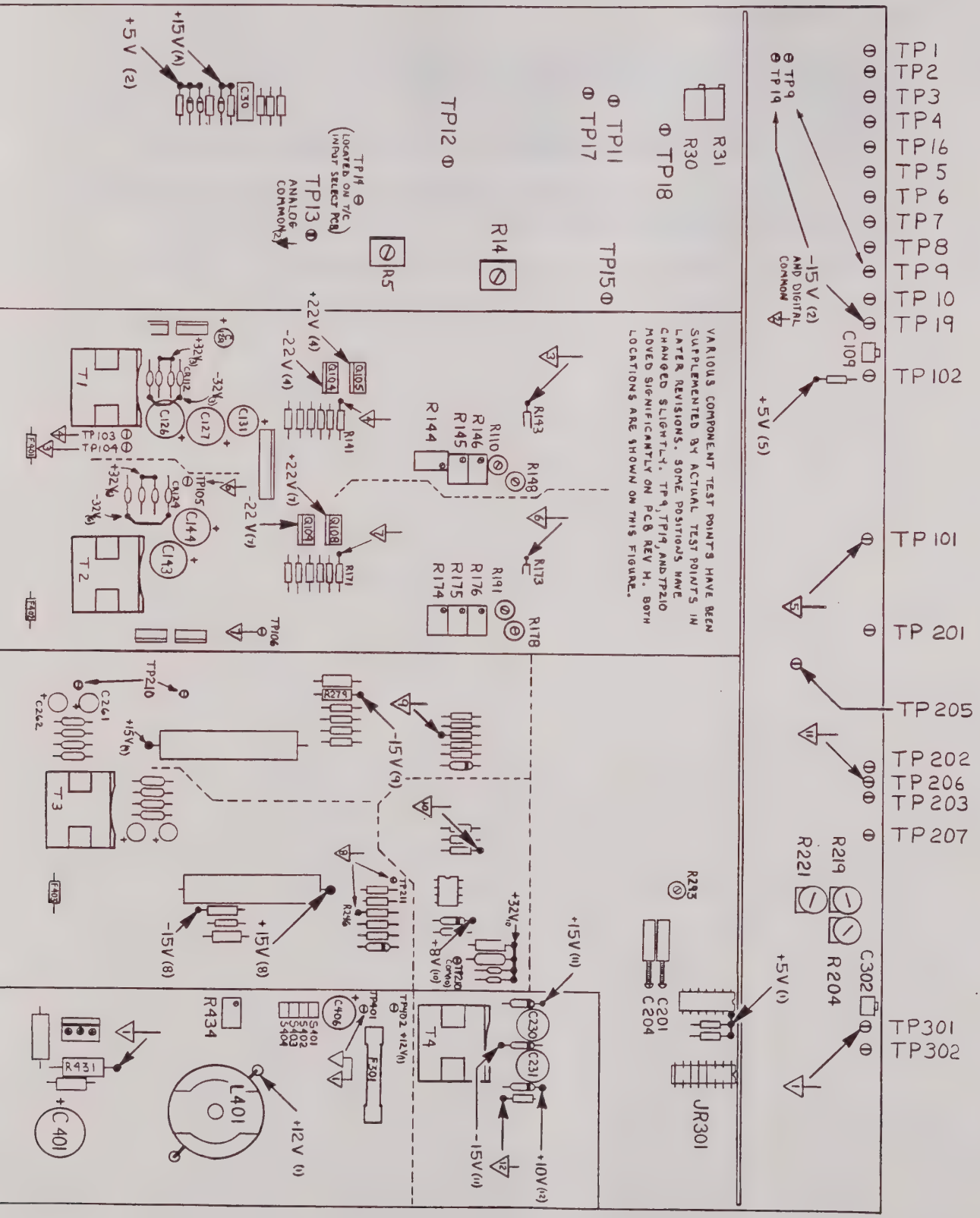


Figure 4-3. Main Circuit Board Test Point/Cal Locations

4-44. Multimeter Volts Calibration

4-45. The following procedure should be used for calibrating the multimeter volts (DC and AC) section of the FT-50010.

1. DC Volts Calibration

   a. In the multimeter input select section of the FT-50010, select the multimeter EXT Input.

   b. In the multimeter section, select DC volts, 2 volt range.

   c. Connect the HI output of a meter calibrator (Fluke 5100B or similar) to the multimeter external V/kΩ/S input. Connect the LO of the calibrator to the multimeter COM input.

   d. Adjust the calibrator output to 1.9000V dc. Adjust R204 in the FT-50010 for a multimeter display of exactly 1.900.

   e. Reverse the polarity of the calibrator output. Verify a multimeter display of -1.900 ± 2 counts.

2. AC Volts Calibration

   a. In the multimeter section of the FT-50010 select the AC volts function, 2 volt range.

   b. Adjust R221 in the multimeter section to the center of its range.

   c. Adjust the meter calibrator for an output of 1.900V at 100 Hz. Adjust R219 for a multimeter display of exactly 1.900 when the front panel is closed.

   d. Adjust the calibrator for an output of 190.0 mV at 100 Hz. Adjust R221 for a multimeter display of exactly 0.190 (in the same 2V range).

   e. Repeat steps 3 and 4 until both readings are correct within 1 count.

   f. Fasten the top of the flexible back shield to the display circuit board using the three mounting screws at the top of the display.

   g. Select the 20V range in the multimeter section.

   h. Set the meter calibrator for an output of 19.00V at 10 kHz. Adjust C201 for a multimeter display of 19.00 with front panel securely closed.

   i. Select the 200V range.

   j. Set the meter calibrator for an output of 110.0V at 10 kHz. Adjust C204 for a multimeter display reading of 110.0 with front panel securely closed.

4-46. Frequency Counter Calibration

4-47. The following procedure should be used for calibrating the frequency counter section of the FT-50010.

1. Make sure the frequency counter shield is in place when this calibration is performed. This is the shield which covers components R102 - R106, among others. The bottom shield must be in place as well, however, the top of the shield must be unfastened from the display circuit board.

2. Connect the frequency generator to the EXT FREQ 1 input and adjust it for 90 kHz, 5V rms. Press the EXT FREQ 1 push button (below the counter display). Turn the front panel trigger level adjust fully ccw.

3. Adjust C109 for the UUT counter reading of 90000 Hz.

4. Adjust the input to 100 Hz at 5V rms.

5. Verify that the UUT counter display reads 100 Hz ± 1 Hz.

6. Apply 110 kHz at 5V rms.

7. Verify that the UUT reads overflow (0.0.0.0.0 Hz).

4-48. Frequency Source Calibration

NOTE: Calibration of the frequency sources should be performed after calibration of the multimeter DC, multimeter low frequency AC frequency counter sections.

4-49. The following procedure should be used to calibrate both frequency sources. Each component designator refers to Frequency Source No. 1, followed by a number enclosed in parentheses which refers to Frequency Source No. 2. Example: R145 (175).

1. Set-Up

   a. Connect a 620Ω ± 12Ω, 4W resistor across the frequency source output.

   b. Connect an oscilloscope across the 620Ω load on the source under test.

2. 50% Duty Cycle

   a. On the A21-51 front panel select the square wave function.

   b. Just below the frequency display, select the frequency source under test (1 or 2).

   c. Adjust the frequency source amplitude for a 20 volt peak to peak square wave as displayed on the oscilloscope.

   d. Adjust the frequency source for an output frequency of 40 Hz ± 1 Hz (as displayed on the A21-50 frequency counter).

   e. At 40 Hz: Adjust R110 (191) for an output duty cycle of 50% ± 1%. (Notice the trimmer varies the length of the lower half-cycle of the square wave, but not the length of the upper half-cycle.) It may not be possible to trip the wave form to 50% on the first attempt if the high frequency duty cycle adjustment is too far out of adjustment. If this happens, go on to step f.

   f. Adjust the frequency source for an output frequency of 1 kHz ± 10 Hz (as displayed on the A21-50 frequency counter).

   g. At 1 kHz: Adjust R146 (176) for an output duty cycle of 50% ± 1%. Doing this will affect the duty cycle at 40 Hz, so the next step is important.

   h. Repeat steps d through g, adjusting (or checking) the duty cycle until it is 50% ± 1% at both 40 Hz and 1 kHz.

   i. In the Multimeter Select Section select the frequency source under test. In the Multimeter Section, select: AC, Volts, 200 Volt range.

   j. In the multimeter section, select: DC, 20 Volt range. Pull out the frequency source DC OFFSET and check for span of at least -18.1V to +18.1V (as indicated by the UUT multimeter).

3. Distortion Adjustment. The purpose here is to adjust the sine wave distortion controls to match its shape to that of a true sine wave.

   a. Display a true sine wave either by displaying it on the oscilloscope from an external generator (Fluke 6011A, or equivalent, set to 1 kHz, 5V rms, see section 9.2 for suggested procedure), or by a graticule overlay (where the sine wave is simply drawn on the screen).

   b. Set the A21-50 frequency source under test to its sine wave output, approximately 1 kHz, 5V rms. Adjust the oscilloscope so this signal is superimposed over the true sine wave.

   c. Adjust R145 (175) and R144 (174) to match the wave forms, especially making sure the positive peak is the same amplitude as the negative peak.

4. Square Wave Amplitude Adjustment

   a. Select the square wave function. In the multimeter input section, select AC volts, 200 Volt range.

   b. Adjust the frequency source Amplitude to maximum, and frequency to 15000 Hz ± 100 Hz.

   c. Adjust R148 (178) until the square wave output amplitude is 21.0 ± 0.2V rms.

   d. Turn on (pull out) the DC offset knob and turn it fully ccw and fully cw. Verify that the square wave amplitude stays at or above 20.1V rms with the 620Ω load.

4-50. Thermometer Calibration

4-51. The following procedure should be used for calibrating the thermometer section.

1. A/D CALIBRATION

   a. Turn Frequency Source #1 and #2 amplitudes down all the way (to reduce interference). Set temperature switch to °F. Set the T/C signal select for External Input. With instrument power off, connect a jumper wire between TP9 (linear pin of U4) and TP19 (digital common, -15V).

   b. Turn power back on and allow the FT-50010 to stabilize for 5 minutes.

   c. Connect equipment as shown in the following figure using input module T/C #1 (or T/C #2). Press the T/C #1 pushbutton. Observe proper polarity.

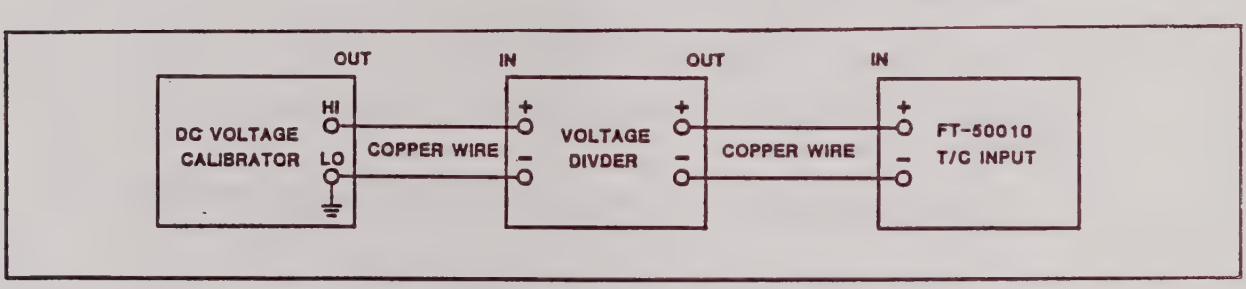


Figure 4-4. Thermometer A/D Calibration

   d. Adjust the calibrator (0.001V) and voltage divider (+100:1) for a thermometer input of +10 μV. Note the resulting temperature display.

   e. Reverse the polarity of the input and again observe the display. Adjust zero potentiometer, R31 until the two readings are of equal magnitude. (The readings should be approximately 1.0°F except for the negative sign.) (Clockwise rotation makes the +100:1 reading smaller and the -100:1 reading larger, ignoring the sign.)

   f. Again source +10 μV. Adjust R14 for a display of 1.0. Reverse input polarity and verify a display of -1.0 ± 0.1°F.

   g. Adjust the calibrator (1.9V) and voltage divider (-100:1) for a thermometer input of -19.000 mV. Adjust -FS potentiometer, R30 for a display of -1900.0 exactly.

   h. Source +19.000 mV. Verify a thermometer display of 1900.0 ± 2-1/2 counts.

   i. Adjust the calibrator (9.9V) and voltage divider (+100:1) for a thermometer input of +99.000 mV. Verify a display of 9900 ± 1 count. Reverse input polarity and verify a display of -9900 ± 1 count.

   j. Remove the jumper wire from TP9 and TP19.

2. REFERENCE JUNCTION DIVIDER NETWORK CALIBRATION

CAUTION

Care should be taken in adjusting the dc calibrator output in the following steps. Excessive calibrator output can damage the reference junction circuitry.

a. Adjust the dc calibrator for an output of 0.0 volts. Use direct output from the calibrator.

b. Connect the (-) output of the calibrator to TP14 (on the T/C switch assembly). Connect the (+) output of the calibrator to TP13.

c. Place a short across the T/C+ and T/C- terminals on T/C #1 input assembly. Select that assembly as the input.

d. Place the select type T/C rotary switch to the K position.

e. Adjust the DC calibrator for an output of 0.57850V. Adjust R5 for a display of exactly 25.0°C or 77.0°F.

f. Disconnect the leads from TP13 and TP14. Remove the short from the T/C input.

3. THERMOCOUPLE INPUT MODULE CALIBRATION

This procedure assumes the thermometer A/D is already calibrated.

a. Construct an ambient temperature lag bath as follows:

(1) Prepare a thermos type container by drilling two holes in its cap to accept the mercury thermometer and thermocouple wires, or use a standard laboratory cork.

(2) Fill this container with room temperature water.

(3) Replace the cap or cork and insert the thermocouple wires and thermometer as shown in the following figure, allowing the bath to stabilize for at least 30 minutes.

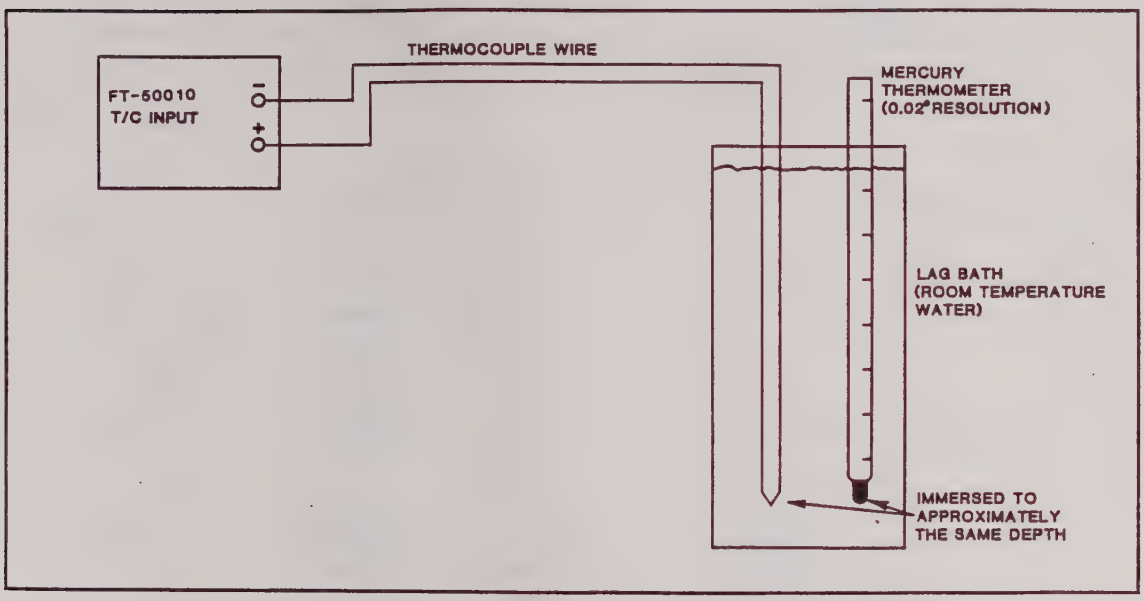


Figure 4-5. Thermocouple Input Module Calibration

b. Connect a K-type thermocouple to one of the T/C (thermocouple) input modules. Immerse the thermocouple probe in a room temperature lag bath as shown in the previous figure.

c. Install the input assembly in the FT-50010 and allow the equipment to stabilize for at least 5 minutes.

d. Set the Type Select rotary switch on the FT-50010 to the K position. Select the °C temperature scale.

e. Read the lag bath temperature using the mercury thermometer. To calibrate the input module, adjust R1 on the input module so the FT-50010 temperature display agrees with the mercury thermometer reading. See section 4-15 if the range of R1 is not sufficient of adjust the input module.

f. Repeat steps b. through e. for the other T/C input module.

4. REFERENCE JUNCTION RESISTOR SELECTION

NOTE: This section needs to be performed only if the range of R1 from the previous section is not enough to allow the instrument to be calibrated. The following table lists values and part numbers that may be used for R3. These are low temperature coefficient metal film resistors. If these values are substituted with parts with a larger temperature coefficient, stability over time may suffer.

VALUE	FLUKE P/N	VALUE	FLUKE P/N
49.9 k	268821	110 k	234708
52.3 k	237248	124 k	288407
54.9 k	271353	140 k	289439
57.6 k	289116	162 k	375998
60.4 k	291419	191 k	375923
63.4 k	235382	237 k	288373
68.1 k	236828	309 k	235283
73.2 k	237222	332 k	289504
78.7 k	289058	464 k	271908
84.5 k	229492	562 k	235358
90.9 k	223537	1.05 M	260737
100 k	248807	OPEN	--

Table 4-9. Reference Junction Bias Resistor Values

5. Remove R3 from the T/C input assembly. Temporarily connect copper wire test lead to TP1 and TP2 on the T/C input module. Connect the test leads to a resistor substitution box as shown in the following figure.

6. Connect a K-type thermocouple to the T/C input assembly and immerse the probe end into a room temperature lag bath as shown in the previous figure.

7. Adjust R1 on the input assembly to the center of its range. Install the input assembly in the FT-50010 and allow the equipment to stabilize for at least 5 minutes.

8. Set the type select rotary switch on the FT-50010 to the K position. Select the °C temperature scale.

9. Read the lag bath temperature using the mercury thermometer. Adjust the resistor substitution box to the value in the above table that yields a FT-50010 temperature display that most nearly matches the lag bath temperature.

10. Disconnect the decade resistor from the T/C input assembly and replace it with a resistor of the value selected.

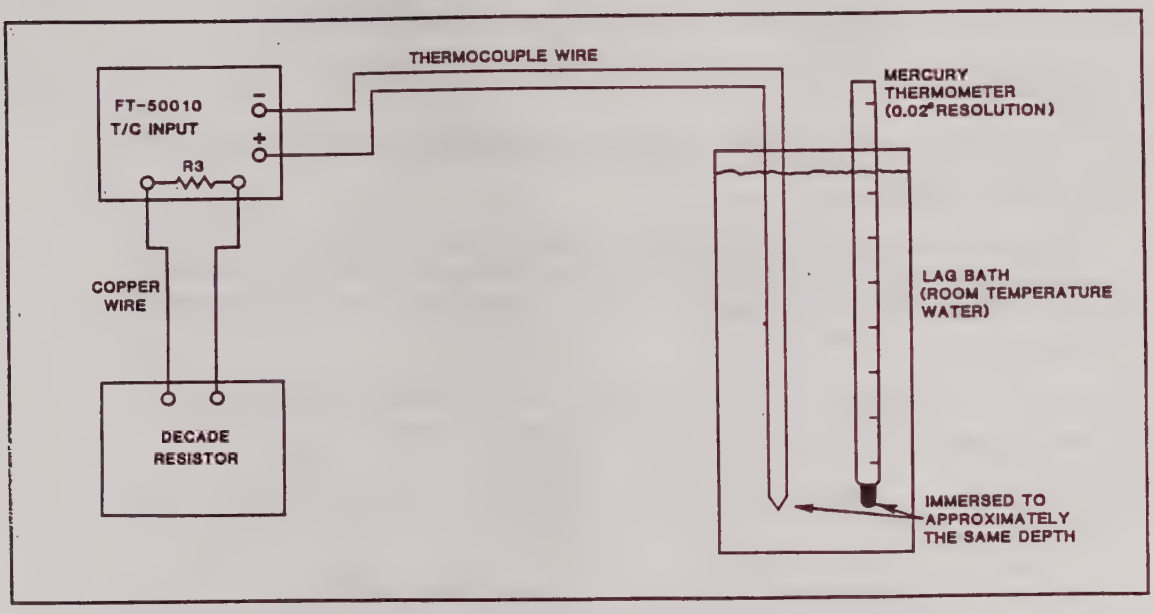


Figure 4-6. Reference Junction Resistor Selection

11. Reconnect the equipment as shown in Figure 4-5, Thermocouple Input Module Calibration, and allow it to stabilize for at least 5 minutes.

12. Adjust R1 on the input assembly so that the FT-50010 temperature display agrees with the mercury thermometer reading.

4-52. Thermocouple Calibrator Output

The Calibrator Output has no internal adjustments and hence requires no calibration.

4-53. Relay Timer Calibration

The following procedure should be used for calibrating the relay timer section of the FT-50010.

1. In the Relay Timer section of the FT-50010, connect a frequency counter between testpoints TP301(common) and TP302.

2. Adjust C302 for a period reading of exactly 100.000 ms (or frequency reading of 10.00000 Hz) on the frequency counter.

4-54. TROUBLE SHOOTING

4-55. This section provides useful trouble shooting information for the A21-50.

4-56. Power Supplies

4-57. This section provides some useful trouble shooting information for the power supply section of the A21-50.

4-58. The inverter power supplies are individually isolatable using switches S401 - S404 for both turn on and trouble shooting purposes. The following table shows the relationship of the switches to each functional section, as well as the typical 24V dc current consumption for each section.

4-59. Note that there should be no loads attached to the UUT outputs and all front panel controls (except FINE) should be turned fully counter clockwise.

SWITCH	ACTIVATES	TYPICAL 24V CURRENT
(none)	Relay timer LCD Relay timer	35 mA (Always active)
S401	Multimeter LCD Current sources	50 mA
S402	DC Voltage sources	45 mA
S403	Freq counter LCD Freq source 2	210 mA
S404	Thermometer LCD Freq source 1	330 mA

NOTE: The total 24V current consumption should not exceed 800mA. If the additional current is much greater than that given in the table, a failure exists, either in the inverter drive circuitry or somewhere on the secondary load side to the inverter. If a group of circuits driven by a single inverter all fail, the fault is probably located in the primary drive circuit or the transformer. (Each transformer has its own primary drive circuit.)

Table 4-10. Inverter Power Supply Currents

4-60. All of the inverters share a common primary ground. There are a total of 11 secondary grounds.

TRANSFORMER	GROUND	CIRCUITRY DRIVEN BY TRANSFORMER
T1	2,3,4	Thermometer Frequency Source 1 LCD 1, for Thermometer
T2	5,6,7	Frequency Source 2 LCD 2, for Audio Frequency
T3	8,9	DC Volts Out
T4	10,11,12	DC mA Out Multimeter LCD 3, for Multimeter
(none)	1	Relay Timer LCD 4, for Relay Timer

NOTE: Ground 1 is on primary side of all transformers. Grounds 2-12 are on secondary sides.

Table 4-11. Inverter Power Supply Grounds

4-61. Sine Wave Distortion Adjustment

4-62. The purpose of the sine wave distortion adjustment is to get the output of the frequency sources as close to a true sine wave as is reasonably possible. The person performing this adjustment should first realize that this adjustment is extremely dependent on the proper calibration of the square wave duty cycle. If any difficulty is encountered in matching the frequency source output to a sinusoid, it is advisable to recheck the 50% duty cycle adjustments (Section 7.5, part 2).

4-63. When using a 6010A or 6011A as the sine wave reference, it is possible to synchronize the frequency source output to the 6010/11 output and to overlay the two wave forms on the display of a dual trace oscilloscope as follows:

1. Adjust the output of the frequency source to 1 kHz, 5V rms as indicated by the UUT frequency counter and multimeter. Connect this output to the channel A input of the oscilloscope.

2. Set the output of the 6010/11 to 1 kHz at approx 5V rms. Connect this output to the channel B input of the oscilloscope.

3. Set up the oscilloscope for normal trigger, alternating display mode, 0.1 ms/div sweep, channel A & B amplitude 1 V/div.

4. Adjust trigger level on the oscilloscope to produce a stable display. The distortion adjustments can now be made by comparing the UUT wave form to the 6010/11 wave form.

SECTION 5

LIST OF REPLACEABLE PARTS AND ASSOCIATED DRAWINGS

TABLE OF DRAWINGS

PARTS LIST, A21-50 FINAL ASSEMBLY, REV C 5-6
PARTS LIST, MAIN BOARD ASSEMBLY, REV B 5-8
PARTS LIST, MAIN BOARD ASSEMBLY, REV J 5-19
PARTS LIST, T/C INPUT ASSEMBLY, REV B 5-29
PARTS LIST, DISPLAY ASSEMBLY, REV - 5-30
PARTS LIST, SWITCH DECK 1 ASSEMBLY, REV - 5-31
PARTS LIST, SWITCH DECK 2 ASSEMBLY, REV - 5-31
PARTS LIST, SWITCH DECK 3 ASSEMBLY, REV - 5-32
PARTS LIST, T/C/ SELECT ASSEMBLY, REV - 5-32
PARTS LIST, MULTIMETER INOUT ASSEMBLY, REV - 5-32

SCHEMATIC, MAIN, REV - (PREREGULATOR)
SCHEMATIC, MAIN, REV - (POWER SUPPLY)
SCHEMATIC, MAIN, REV - (THERMOMETER)
SCHEMATIC, MAIN, REV - (THERMOMETER CALIBRATOR)
SCHEMATIC, MAIN, REV - (AUDIO FREQUENCY COUNTER)
SCHEMATIC, MAIN, REV - (FREQUENCY SOURCES)
SCHEMATIC, MAIN, REV - (MULTIMETER)
SCHEMATIC, MAIN, REV - (VOLTAGE & CURRENT SOURCES)
SCHEMATIC, MAIN, REV - (RELAY TIMER)
SCHEMATIC, MAIN, REV E (PREREGULATOR)
SCHEMATIC, MAIN, REV E (POWER SUPPLY)
SCHEMATIC, MAIN, REV E (THERMOMETER)
SCHEMATIC, MAIN, REV E (THERMOMETER CALIBRATOR)
SCHEMATIC, MAIN, REV E (AUDIO FREQUENCY COUNTER)
SCHEMATIC, MAIN, REV E (FREQUENCY SOURCES)
SCHEMATIC, MAIN, REV E (MULTIMETER)
SCHEMATIC, MAIN, REV E (VOLTAGE & CURRENT SOURCES)
SCHEMATIC, MAIN, REV E (RELAY TIMER)
SCHEMATIC, THERMOCOUPLE INPUT, REV B
SCHEMATIC, DISPLAY, REV B - 2 SHEETS

REFERENCE DESIGNATOR, REV B, MAIN PCB ASSEMBLY
    ASSEMBLY, MAIN PCB, REV B (AUTO INSERTED) - 2 SHEETS
    ASSEMBLY, MAIN PCB, REV B - 4 SHEETS
REFERENCE DESIGNATOR, REV J, MAIN PCB ASSEMBLY
    ASSEMBLY, MAIN PCB, REV J (AUTO INSERTED) - 2 SHEETS
    ASSEMBLY, MAIN PCB, REV J - 4 SHEETS
    ASSEMBLY, THERMOCOUPLE INPUT, REV B
    ASSEMBLY, DISPLAY, REV - - 2 SHEETS
    ASSEMBLY, SWITCH DECK 1, REV -
    ASSEMBLY, MULTIMETER INPUT SELECT
    ASSEMBLY, RANGE SELECT SWITCH
    ASSEMBLY, THERMOCOUPLE SELECT
    ASSEMBLY, MULTIMETER INPUT
    ASSEMBLY, FINAL - 10 SHEETS

5-1. INTRODUCTION

All components are listed according to the circuit board where they are located.

5-2. Parts lists include the following information:

1. Reference designation
2. Description of each part
3. Fluke part number, class code
4. Item number
5. Total quantity per assembly

5-3. How to Obtain Parts

1. Components may be ordered from John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE PART NUMBER. If you can identify the manufacturer by the component markings, you may order the part directly from the manufacturer. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

2. To ensure prompt and efficient handling of your order, include the following information:

   a. Quantity

   b. Fluke Part Number

   c. Description of part

   d. Printed circuit board part number and revision letter as printed in ink on the circuit board.

   e. The reference designation or item number of the part

   f. Instrument model and serial number.

5-4. APPLICABILITY

5-5. This manual is for the Solar Turbines FT-50010 Turbine Electrical System Test Set. This unit is identified within Fluke as Model A21-50. An earlier version of the FT-50010 was designated within Fluke as Model A21-44. Although the two units are very similar, this newer manual is intended primarily for the A21-50. The two FT-50010 varieties may be most easily distinguished by the absence of the Trigger Level adjustment from the A21-44, which is located above the two Frequency Counter Inputs on the A21-50. Any PCBs which have remained common to both varieties are identified on their drawings with an A21-44 prefix. PCBs unique to the A21-50 have an A21-50 prefix.

5-6. Besides including the latest drawings for the main assembly and all circuit boards, this Service Manual also includes the main PCB parts lists and drawings for Assembly Revision B with associated schematic "Rev -" and Ref Des "Rev -". This gives the service technician sufficient data to identify, and if necessary replace, components from any revision of the A21-50 main PCB.

5-7. With few exceptions, where a difference exists between a part on Assy Rev B vs Rev J, then the Rev J part is preferred even if your Assy is prior to Rev J. In a few cases listed below, when one part is changed to a newer type then one or more other components must also change. We therefor suggest that you attempt to identify components using the later drawings, even when you have an earlier unit. Then refer to the earlier drawings if necessary, and review the exceptions noted below.

5-8. Main PCB Revisions vs Assembly Revisions[1]

PCB	ASSY	COMMENT
D	0,A	Original A21-50 PCB (the last A21-44 Main PCB was Rev C).
E	B	Oldest drawing in this manual. Insignificant change from prior PCB.
F	C,D,E	Minor changes to stabilize frequency out offset, and frequency counter.
G	F	Redesigned output stage in frequency generators.
H	G,H,J	Latest main PCB covered in this manual. Improved reliability of U404.

[1]Terminology: 'PCB' or 'PWB' generally refers to the bare circuit board, or identifying noun, or its revision letter. These are designated on the PCB by etched characters in the form xxxxx-3nnn REV _ where the x's resembles the Model of the instrument and nnn is a number following a '3'. For the latest A21-50 Main PCB this is A21-50-3001 REV H. The term PCB Assembly or Assy or PCA (printed circuit assy) refers to the PCB with components installed or its Revision letter. This is usually designated on the PCB by an etched or silk screened Title, replacement part number for the Assy, and a hand written or stamped revision letter. For the latest A21-50 Main PCB Assy this resembles MAIN PCB ASSY 718403 REV _, where the "_" has a J written in.

5-9. Significant Component Changes and Dependencies

Note: Various Product Change Notices (PCN) exist for this product. Refer to the PCNs for details and explanation of the changes. Some of the following items are covered in greater detail in PCNs. PCNs are available thru the Fluke Service Centers.

1. The three fuses F401 thru F403 should now all be 3 Amp devices to avoid nuisance blowing. See parts list for part numbers.

2. If either or both T1 and T2 are changed to the newer replacements then U110 and U115, respectively, must be brought current if not already so. The newer transformers provide extra voltage for the offset circuits in the frequency output sections. (The newest U110 and U115 may be used with the older T1 and T2.)

3. C412 and R411 must change together to the latest values. These are to maintain proper shape and dead time for the two clock signals and improved reliability of U404.

4. If either U108 or U112 in the frequency output sections needs replacement, then due to obsolescence of those parts by their manufacturers, a replacement kit containing a small daughter board and substantially different circuitry must be installed (kit part number is 872812). Instructions come as part of the kit. Each kit replaces components in one output section. One section may remain original while one is updated. The circuit differences may be noted by comparing the schematics of the two revisions provided in this manual. To identify other components in the redesigned areas of the output stages on an Assy prior to Rev F, refer to the parts list and drawings for Assy Rev B.

5. If reaching a low enough frequency is difficult on the frequency output sections then R109 or R187, respectively, may be changed to the latest value.

6. If replacement of any of the older style front panel binding posts becomes necessary, then because of availability and uniformity we suggest that all three binding posts be replaced with the current style. Identification of old vs new is based upon height. The older style extends 1.35 inches (34mm) when screwed closed. The newer style extends only 1 inch (25mm) when closed. Refer to the Final Assembly drawing (sheet 2) and Parts list for identification of appropriate parts and hardware.

JFPN: 708941
NOUN: A21-50
DESC: SOLAR TURBINES ELEC. SYSTEMS TEST SET
Rev: C

REFDES	JFPN	ITM	Noun	Description	QPA
FL	631937	217	FILTER	FILTER,LINE,115V/3A,250V/3A	1
H	631291	137	WASHER	WASHER,NON-TURN,BR,.375 ID	1
H	110817	138	WASHER	WASHER,LOCK,INTRNL,STL,.267ID	2
H	129957	139	WASHER	WASHER,LOCK,INTRNL,STL,.387ID	4
H	110320	140	WASHER	WASHER,LOCK,INTRNL,STL,.176ID	1
H	110601	141	NUT	NUT,HEX,BR,1/4-32	2
H	195255	142	NUT,METAL	NUT,CAP,EXT.LOCK,STL,4-40	8
H	110510	143	NUT	NUT,HEX,STL,3/8-32	2
H	228890	166	SCREW	SCREW,PH,P,LOCK,STL,8-32,.250	1
H	177022	167	SCREW	SCREW,PH,P,SEMS,STL,6-32,.375	1
H	745877	169	WASHER	WASHER,SHLDR,ISOLATING,D,3/8	0
H	745943	171	WASHER	WASHER,FLAT,NYLON,.380 ID,.031 TK	4
H	631614	179	NUT	NUT,HEX,BR,8-32	2
H	631606	180	WASHER	WASHER,FLAT,BRASS,#8,0.032 THK	5
H	110841	231	NUT	NUT,HEX,ELAST STOP,STL,6-32,.125	9
H	272591	232	SCREW	SCREW,PH,P,SEMS,STL,6-32,.625	2
H	177022	233	SCREW	SCREW,PH,P,SEMS,STL,6-32,.375	4
H	110536	234	NUT	NUT,HEX,STL,10-32	1
H	178533	235	SCREW	SCREW,PH,P,SEMS,STL,6-32,.250	3
H	281196	236	SCREW	SCREW,PH,P SEMS,STL,4-40,.375	1
H	658088	237	SCREW	SCREW,RH,SL,SHLDR,STL,8-32,.285	2
H	745869	238	RIVET	RIVET,PUSH,BI,NYL,0.118X0.217	4
H	146225	239	WASHER	WASHER,FLAT,SS,.125,.317,.030	4
H	353060	240	SCREW	SCREW,PH,P,SEMS,STL,4-40,.500	4
H	130021	241	WASHER	WASHER,FLAT,PHENOLIC,#4,0.063 THK	4
H	115006	242	SCREW	SCREW,RH,SL,NYL,6-32,.500	6
H	110288	243	WASHER	WASHER,FLAT,STL,.170,.375,.031	3
H	111310	244	WASHER	WASHER,FLAT,BR,.147,.312,.032	0
H	740456	408	SCREW	SCREW,FH,P,SS,10-32,.750	6
M3	762716	501	FLUKE-52	FLUKE-52 K/J THERMOMETER	1
M3	827568	502	FLUKE-87	MULTIMETER W/ENGLISH MANUAL	1
MP	723254	101	A21-50-8101	FRONT PANEL	1
MP	655480	102	A21-44-2011	BUSHING,SWITCH	2
MP	718635	106	A21-50-4009	MULTIMETER INPUT ASSY	1
MP	341396	107	M00-200-707	ASSY,PUTTY KNURLED KNOB-PUTTY DECAL	4
MP	341404	108	M00-200-708	ASSY, PUTTY POINTER KNOB-PUTTY DECAL	4
MP	460329	127	HOLDER PART	HLDR PART,FUSE,BODY 1/4X1-1/4,5X20MM	2
MP	460238	128	HOLDER PART	HLDR PART,FUSE,CAP,1/4X1-1/4	2
MP	149450	156	SLEEVING	SLEEV,POLYOL,SHRINK,.125-.062ID,BLACK	0
MP	196683	158	SLEEVING	SLEEV,POLYOL,SHRINK,.500-.250ID,BLACK	3
MP	172080	161	CABLE ACCESSORY	CABLE ACCESS,TIE,4.00L,.10W,.75 DIA	4
MP	407908	162	CABLE TIE ANCHOR	CABLE TIE ANCHOR,ADHSV,.160TIE	2
MP	403253	164	SPACER	SPACER,.312 RND,NYL,6-32,.875	1
MP	721076	165	SPACER	SPACER,.250 HEX,BR,8-32,.500	1
MP	850297	175	5725A-2703-02	BINDING POST, BLACK	1
MP	850292	176	5725A-2703-01	BINDING POST-RED	2
MP	823187	177	5725A-2033	INSULATOR,BINDING POST,FRONT(MED P.)	3
MP	823211	178	5725A-2038	INSULATOR, REAR	3
MP	718403	201	A21-50-4001	MAIN BOARD ASSEMBLY	1
MP	648634	202	A21-44-4002	T/C INPUT ASSY	2
MP	648642	203	A21-44-4003	DISPLAY ASSY	1
MP	718619	204	A21-50-4004	SWITCH DECK 1, ASSY	1
MP	718627	205	A21-50-4005	SWITCH DECK 2, ASSY	1
MP	648675	206	A21-44-4006	SW. DECK 3 ASSY	1
MP	734889	207	A21-50-4008	T/C SELECT ASSY	1
MP	727933	208	A21-50-2006	POWER SUPPLY SHIELD	1
MP	727958	209	A21-50-2701	FRAME ASSY	1
MP	727917	210	A21-50-2003	INTERNAL SUPPORT BRACKET	2
MP	727941	211	A21-50-2007	FREQUENCY COUNTER SHIELD	1
MP	727925	212	A21-50-2004	ISOTHERMAL SUPPORT BRACKET	1
MP	464123	213	2180A-2003	INPUT DRAWER	2
MP	651331	214	A21-44-2502	HINGE ARM MODIFIED	1

JFPN: 708941
NOUN: A21-50
DESC: SOLAR TURBINES ELEC. SYSTEMS TEST SET
Rev: C

REFDES	JFPN	ITM	Noun	Description	QPA
MP	722363	216	A21-50-8014	MAIN PCB ASSEMBLY SHIELD	1
MP	734954	223	2590A-2016	INSULATOR, MAIN PCB ASSY	1
MP	761809	224	A21-50-2016	BRACKET, FRONT PANEL	1
MP	306217	226	INSULATION PART	INSUL PART,TRANS,PLASTIC,TO-3,FILM	1
MP	508630	227	INSULATION PART	INSUL PART,POWER,SI,.687,.562	4
MP	298836	230	8400A-2031	CARD-GUIDE	0
MP	113852	248	SLEEVING	SLEEV,POLYOL,SHRINK,.187-.093ID,BLACK	0
MP	100073	249	GROMMET	GROMMET,SLOT,RUBBER,.625,.062	2
MP	426759	250	8040A-2001-2	BUTTON,RANGE SWITCH, DARK PUTTY GREY	6
MP	425900	251	8040A-2001-1	BUTTON,FUNCTION SWITCH, PUTTY GREY	1
MP	295048	252	WASHER	WASHER,SHLDR,NYL,.194,.500,.050	1
MP	333989	253	WASHER	WASHER,FLAT,FIBER,.196,.500,.031	1
MP	166322	254	BRACKET	BRACKET,RT ANGLE,STL,8-32	1
MP	722389	402	A21-50-8015	VELCRO FASTENER	2
MP	722439	403	A21-50-8007	POUCH, VINYL	1
MP	722801	404	A21-50-8011	CARRYING CASE, ALUMINUM	1
MP	722371	405	A21-50-8016	KEY, CARRYING CASE	2
MP	472795	407	M00-800-579	NAMEPLATE, SERIAL -REAR PANEL-	1
MP	868497	409	A21-50-8017	PANEL SUPPORT BRACKET FOR A21-50-8011	4
MP	868492	410	A21-50-2501	MODIFIED PANEL SUPPORT BRACKET	2
W	884770	105	A21-44-4401	CABLE SET, FRONT PANEL	1
W	655456	215	A21-44-4409	POWER CABLE ASSY	1
CR412	723809	120	LED	LED,GREEN,PANEL MT WITH WIRE LEADS	1
CR413	508242	218	DIODE 1N6096	DIODE,SI,40 PIV,25.0 AMP	1
F001	109199	125	FUSE	FUSE,.25X1.25,3A,250V,FAST	1
F002	109173	126	FUSE	FUSE,.25X1.25,2A,250V,FAST	1
J012	438226	118	RFC-4400-30-15	RF CABLE ASSY	0
J014	734905	119	RFC-4400-30-17	BNC/CONHEX CABLE	0
J015	734905	119	RFC-4400-30-17	BNC/CONHEX CABLE	0
J018	438226	118	RFC-4400-30-15	RF CABLE ASSY	0
J025	643809	135	CONNECTOR	CONN,CIRC,PANEL,REC,4 CONTACT	1
J027	651414	103	A21-44-4404	AMPLITUDE ADJUST,CABLE ASSY	1
J028	651414	103	A21-44-4404	AMPLITUDE ADJUST,CABLE ASSY	1
J030	734913	111	A21-50-4405	THRESHOLD ADJUST, CABLE ASSEMBLY	1
J038	644021	136	CONNECTOR	CONN,CIRC,PANEL,REC,3 CONTACT	1
P031	734905	119	RFC-4400-30-17	BNC/CONHEX CABLE	1
P032	734905	119	RFC-4400-30-17	BNC/CONHEX CABLE	1
P033	438226	118	RFC-4400-30-15	RF CABLE ASSY	1
P034	438226	118	RFC-4400-30-15	RF CABLE ASSY	1
P035	152033	131	CONNECTOR	CONN,COAX,BNC(F),PANEL	1
P036	152033	131	CONNECTOR	CONN,COAX,BNC(F),PANEL	1
P037	152033	131	CONNECTOR	CONN,COAX,BNC(F),PANEL	1
Q402	523639	219	NPN,POWER 2N5039	TRANSISTOR,SI,BV=120V,140W,TO-3	1
R079	682930	112	RESISTOR,VAR	RES,VAR,WW,10K,+-5%,2W,BSH,MTG	1
R080	682922	115	RESISTOR,VAR	RES,VAR,WW,1K,+-5%,2W,BSH,MTG	1
R114	733782	117	RESISTOR,VAR	RES,VAR,CERM,250K,+-20%,2W	1
R150	682914	116	RESISTOR,VAR	RES,VAR,WW,200,+-5%,2W,BSH,MTG	1
R151	682930	112	RESISTOR,VAR	RES,VAR,WW,10K,+-5%,2W,BSH,MTG	1
R152	682948	113	RESISTOR,VAR	RES,VAR,WW,100K,+-5%,2W,BSH,MTG	1
R153	631457	114	RESISTOR,VAR	RES,VAR,CERM,100K,+-10%,1W	1
R180	682914	116	RESISTOR,VAR	RES,VAR,WW,200,+-5%,2W,BSH,MTG	1
R181	682930	112	RESISTOR,VAR	RES,VAR,WW,10K,+-5%,2W,BSH,MTG	1
R182	682948	113	RESISTOR,VAR	RES,VAR,WW,100K,+-5%,2W,BSH,MTG	1
R183	631457	114	RESISTOR,VAR	RES,VAR,CERM,100K,+-10%,1W	1
R264	682930	112	RESISTOR,VAR	RES,VAR,WW,10K,+-5%,2W,BSH,MTG	1
R265	682922	115	RESISTOR,VAR	RES,VAR,WW,1K,+-5%,2W,BSH,MTG	1
R280	682930	112	RESISTOR,VAR	RES,VAR,WW,10K,+-5%,2W,BSH,MTG	1
R281	682922	115	RESISTOR,VAR	RES,VAR,WW,1K,+-5%,2W,BSH,MTG	1
R289	682930	112	RESISTOR,VAR	RES,VAR,WW,10K,+-5%,2W,BSH,MTG	1
R290	682922	115	RESISTOR,VAR	RES,VAR,WW,1K,+-5%,2W,BSH,MTG	1
S045	615054	124	SWITCH	SWITCH,ROCKER,DPST,6A	1
S046	634741	104	A21-44-8008	SWITCH,BCD T/C SELECT	1

JFPN: 708941
NOUN: A21-50
DESC: SOLAR TURBINES ELEC. SYSTEMS TEST SET
Rev: C

REFDES	JFPN	ITM	Noun	Description	QPA
U004	875336	220	NMOS 3874	IC,NMOS,8BIT MICROCOMPTR W/PROM SOCKT	1
U010	723338	221	MOS P2764A	IC,NMOS,8K EPROM,OTP	1
XQ402	342816	225	SOCKET	SOCKET,TRANS,TO-3	1

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NOUN: A21-50-4001
DESC: MAIN BOARD ASSEMBLY
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REFDES	JFPN	GPITM	Noun	Description	QPA
H	745869	01215	RIVET	RIVET,PUSH,BI,NYL,0.118X0.217	9
H	146225	01217	WASHER	WASHER,FLAT,SS,.125,.317,.030	9
H	155473	01218	SPACER	SPACER,.250 RND,CERAMIC,.135,.500	4
H	393785	01220	NUT	NUT,BROACH,STL,6-32	7
MP	873245	01226	A21-44-2014	DECAL, PATENT 4445111 IDENTIFICATION	1
MP	718411	AI001	A21-50-3001	PCB, MAIN BOARD	1
MP	515635	01014	8050A-2007	SUPPORT, HYBRID	2
MP	740738	01199	HEAT DISSIPATOR	HEAT DIS,HORIZ,1.860,1.062,.500,TO-3	2
MP	524934	01201	HEAT DISSIPATOR	HEAT DIS,VERT,1.25X.875X.25,TO-220	7
MP	386235	01202	HEAT DISSIPATOR	HEAT DIS,PWB MTG,1.380,2.000,.500	2
XU	370304	01204	SOCKET	SOCKET,IC,14 PIN	2
XU	429282	01206	SOCKET	SOCKET,IC,40 PIN	1
C001	148536	01086	CAPACITOR	CAP,MICA,47PF,+-5%,500V	1
C002	364042	01087	CAPACITOR	CAP,POLYPR,0.47UF,+-5%,50V,HERMETIC	1
C003	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C004	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C005	106732	01093	CAPACITOR	CAP,CER,0.0012UF,+-10%,500V,Z5R	1
C006	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C007	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C008	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C009	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C010	306522	01094	CAPACITOR	CAP,POLYCA,2.2UF,+-10%,100V	1
C011	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C012	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C013	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C014	330662	01088	CAPACITOR	CAP,TA,10UF,+-20%,20V	1
C015	330662	01088	CAPACITOR	CAP,TA,10UF,+-20%,20V	1
C016	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C017	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C018	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C020	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C023	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C024	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C025	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C026	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C027	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C028	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C029	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C030	162008	01097	CAPACITOR	CAP,POLYES,0.047UF,+-10%,250V	1
C031	161919	01133	CAPACITOR	CAP,TA,1UF,+-10%,35V	1
C032	161919	01133	CAPACITOR	CAP,TA,1UF,+-10%,35V	1
C034	161919	01133	CAPACITOR	CAP,TA,1UF,+-10%,35V	1
C035	309849	01098	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C036	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C037	306522	01094	CAPACITOR	CAP,POLYCA,2.2UF,+-10%,100V	1
C038	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C040	369124	01100	CAPACITOR	CAP,POLYES,0.47UF,+-10%,100V	1

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REFDES	JFPN	GPITM	Noun	Description	QPA
C041	160317	01099	CAPACITOR	CAP,MICA,33PF,+-5%,500V	1
C101	175224	01122	CAPACITOR	CAP,MICA,12PF,+-5%,500V	1
C102	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C103	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C104	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C105	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C106	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C107	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C108	148551	01123	CAPACITOR	CAP,MICA,22PF,+-5%,500V	1
C109	404301	01102	CAPACITOR	CAP,VAR,6-50PF,250V,CER	1
C111	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C112	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C113	175216	01121	CAPACITOR	CAP,MICA,10PF,+-10%,500V	1
C114	355420	01132	CAPACITOR	CAP,CER,0.05UF,+80-20%,1000V,Z5U	1
C115	355420	01132	CAPACITOR	CAP,CER,0.05UF,+80-20%,1000V,Z5U	1
C116	357806	01104	CAPACITOR	CAP,CER,1000PF,+-10%,500V,X5S	1
C118	739987	01126	CAPACITOR	CAP,POLYES,4700PF,+-5%,50V	1
C119	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C120	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C121	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C122	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C123	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C124	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C125	354852	01106	CAPACITOR	CAP,CER,33PF,+-2%,50V,C0G	1
C126	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C127	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C128	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C129	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C130	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C131	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C132	368613	01124	CAPACITOR	CAP,CER,470PF,+-10%,1000V,Z5F	1
C133	357806	01104	CAPACITOR	CAP,CER,1000PF,+-10%,500V,X5S	1
C135	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C136	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C137	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C138	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C139	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C140	739987	01126	CAPACITOR	CAP,POLYES,4700PF,+-5%,50V	1
C141	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C142	354852	01106	CAPACITOR	CAP,CER,33PF,+-2%,50V,C0G	1
C143	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C144	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C145	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C146	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C147	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C148	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C151	368613	01124	CAPACITOR	CAP,CER,470PF,+-10%,1000V,Z5F	1
C152	358275	01131	CAPACITOR	CAP,CER,470PF,+-20%,100V,X7R	1
C154	358275	01131	CAPACITOR	CAP,CER,470PF,+-20%,100V,X7R	1
C201	435016	01109	CAPACITOR	CAP,VAR,0.25-1.5PF,1700V,TEFLON	1
C202	148452	01127	CAPACITOR	CAP,MICA,270PF,+-5%,500V	1
C203	148478	01108	CAPACITOR	CAP,MICA,150PF,+-5%,500V	1
C204	435016	01109	CAPACITOR	CAP,VAR,0.25-1.5PF,1700V,TEFLON	1
C205	192518	01128	CAPACITOR	CAP,MICA,3300PF,+-2%,500V	1
C206	162008	01097	CAPACITOR	CAP,POLYES,0.047UF,+-10%,250V	1
C207	148478	01108	CAPACITOR	CAP,MICA,150PF,+-5%,500V	1
C208	193623	01110	CAPACITOR	CAP,TA,10UF,+-20%,15V	1
C209	448183	01111	CAPACITOR	CAP,POLYES,0.022UF,+-10%,1000V	1
C210	436840	01112	CAPACITOR	CAP,AL,22UF,+50-20%,35V	1
C211	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C216	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C218	161927	01114	CAPACITOR	CAP,TA,2.2UF,+-20%,20V	1

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REFDES	JFPN	GPITM	Noun	Description	QPA
C219	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C229	330662	01088	CAPACITOR	CAP,TA,10UF,+-20%,20V	1
C230	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C231	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C232	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C233	193623	01110	CAPACITOR	CAP,TA,10UF,+-20%,15V	1
C234	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C236	148494	01129	CAPACITOR	CAP,MICA,100PF,+-5%,500V	1
C248	148924	01103	CAPACITOR	CAP,CER,0.05UF,+80-20%,25V,Y5U	1
C249	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C250	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C251	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C252	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C253	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C254	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C255	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C256	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C257	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C258	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C259	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C260	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C261	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C262	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C263	148924	01103	CAPACITOR	CAP,CER,0.05UF,+80-20%,25V,Y5U	1
C264	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C265	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C266	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C267	614362	01115	CAPACITOR	CAP,AL,22UF,+-20%,50V	1
C269	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C270	148924	01103	CAPACITOR	CAP,CER,0.05UF,+80-20%,25V,Y5U	1
C271	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C301	175216	01121	CAPACITOR	CAP,MICA,10PF,+-10%,500V	1
C302	404301	01102	CAPACITOR	CAP,VAR,6-50PF,250V,CER	1
C304	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C305	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C306	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C309	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C310	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C311	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C312	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C313	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C314	368613	01124	CAPACITOR	CAP,CER,470PF,+-10%,1000V,Z5F	1
C401	512657	01116	CAPACITOR	CAP,AL,190UF,+100-10%,100V	1
C402	309849	01098	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C403	148387	01125	CAPACITOR	CAP,MICA,1000PF,+-5%,500V	1
C404	436113	01120	CAPACITOR	CAP,POLYES,0.22UF,+-10%,100V	1
C405	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C406	494575	01118	CAPACITOR	CAP,AL,470UF,+100-10%,25V	1
C407	393439	01119	CAPACITOR	CAP,POLYES,0.1UF,+-10%,100V	1
C408	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C409	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C410	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C411	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C412	512848	01134	CAPACITOR	CAP,CER,100PF,+-2%,100V,C0G	1
C413	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C414	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C415	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C416	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C417	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C418	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
CR015	203323	AI081	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1
CR016	203323	AI081	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1

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REFDES	JFPN	GPITM	Noun	Description	QPA
CR017	203323	AI081	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1
CR018	203323	AI081	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1
CR020	203323	AI081	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1
CR025	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR026	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR027	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR028	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR029	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR030	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR101	381806	01141	DIODE 1N3062	DIODE,SI,BV= 50.0V,IO= 50MA,250 MW	1
CR102	381806	01141	DIODE 1N3062	DIODE,SI,BV= 50.0V,IO= 50MA,250 MW	1
CR104	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR105	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR106	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR107	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR108	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR109	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR110	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR111	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR112	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR113	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR114	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR115	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR116	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR117	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR118	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR119	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR120	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR121	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR122	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR123	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR124	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR125	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR126	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR127	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR128	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR129	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR130	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR131	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR201	347559	01144	DIODE	DIODE,SI,50 PIV,2 AMP,SELECTED IR	1
CR202	348177	01145	DIODE	DIODE,SI,BV=20V,IO=50MA,SELECTED IR	1
CR203	348177	01145	DIODE	DIODE,SI,BV=20V,IO=50MA,SELECTED IR	1
CR209	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR210	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR211	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR251	203323	AI081	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1
CR252	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR253	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR254	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR255	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR256	203323	AI081	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1
CR257	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR258	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR259	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR260	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR262	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR263	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR264	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR265	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR301	483701	01146	DIODE	DIODE,SI,100 PIV,5.0 AMP	1
CR401	483701	01146	DIODE	DIODE,SI,100 PIV,5.0 AMP	1
J01A	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	1

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J01B	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	1
J002	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	1
J003	631309	01210	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,72 POS	1
J004	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	1
J005	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	1
J006	631309	01210	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,72 POS	1
J007	520148	01212	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,44 POS	1
J008	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	1
J009	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	1
JR301	495507	01203	JUMPER	JUMPER,DIP,.300CTR,PROGRAM,8POS	1
L101	461533	01188	INDUCTOR	INDUCTOR,560UH,+-5%,6MHZ,SHLD	1
L102	461533	01188	INDUCTOR	INDUCTOR,560UH,+-5%,6MHZ,SHLD	1
L252	174755	01190	INDUCTOR	INDUCTOR,100UH,+-5%,12MHZ,SHLD	1
L401	490888	01009	2030A-6402	CHOKE	1
P010	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P011	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P013	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P017	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P019	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P020	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P021	631176	01208	HEADER	HEADER,1 ROW,.100CTR,6 PIN	1
P022	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P023	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P024	380022	01214	HEADER	HEADER,1 ROW,.156CTR,3 PIN	1
P029	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
Q005	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q006	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q007	419283	01157	JFET,DUAL,N-CHAN	TRANSISTOR,SI,N-JFET,DUAL,TO-71	1
Q008	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q009	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q010	429977	01154	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,REMOTE CUTOFF	1
Q011	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q013	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q014	476911	01011	2180A-4501	DUAL FET,SELECTED OFFSET	1
Q015	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q016	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q017	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q023	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q024	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q025	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q101	403634	01159	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,UHF/VHF USE	1
Q102	685446	01161	NPN,POWER TIP31C	TRANSISTOR,SI,BV=100V,40W,TO-220	1
Q103	685453	01162	PNP,POWER TIP30C	TRANSISTOR,SI,BV=100V, 2W,TO-220	1
Q104	685453	01162	PNP,POWER TIP30C	TRANSISTOR,SI,BV=100V, 2W,TO-220	1
Q105	685446	01161	NPN,POWER TIP31C	TRANSISTOR,SI,BV=100V,40W,TO-220	1
Q106	685446	01161	NPN,POWER TIP31C	TRANSISTOR,SI,BV=100V,40W,TO-220	1
Q107	685453	01162	PNP,POWER TIP30C	TRANSISTOR,SI,BV=100V, 2W,TO-220	1
Q108	685446	01161	NPN,POWER TIP31C	TRANSISTOR,SI,BV=100V,40W,TO-220	1
Q109	685453	01162	PNP,POWER TIP30C	TRANSISTOR,SI,BV=100V, 2W,TO-220	1
Q201	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q202	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q205	195974	01163	PNP 2N3906	TRANSISTOR,SI,PNP,SMALL SIGNAL	1
Q251	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q252	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q254	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q255	381731	01164	NPN,POWER MPSU10	TRANSISTOR,SI,BV=300V, 10W,TO-202	1
Q255	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q257	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q258	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q401	325753	01165	PNP,POWER D45C5	TRANSISTOR,SI,BV=45V,27W,TO-220	1
Q403	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q405	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1

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Q406	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q408	477331	01166	NPN,POWER MPSU01A	TRANSISTOR,SI,BV= 50V, 10W,TO-202	1
Q409	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q410	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q411	477331	01166	NPN,POWER MPSU01A	TRANSISTOR,SI,BV= 50V, 10W,TO-202	1
Q412	477331	01166	NPN,POWER MPSU01A	TRANSISTOR,SI,BV= 50V, 10W,TO-202	1
Q413	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q414	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q415	477331	01166	NPN,POWER MPSU01A	TRANSISTOR,SI,BV= 50V, 10W,TO-202	1
Q416	477331	01166	NPN,POWER MPSU01A	TRANSISTOR,SI,BV= 50V, 10W,TO-202	1
Q417	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q418	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q419	477331	01166	NPN,POWER MPSU01A	TRANSISTOR,SI,BV= 50V, 10W,TO-202	1
R002	110015	01018	RESISTOR	RES,CC,47K,+-10%,2W	1
R003	479030	01058	RESISTOR	RES,MF,SET,TC MATCHED	1
R004	479030	01058	RESISTOR	RES,MF,SET,TC MATCHED	0
R005	275743	01062	RESISTOR,VAR	RES,VAR,CERM,200,+-10%,0.5W	1
R006	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R008	348813	AI008	RESISTOR	RES,CF,3.3K,+-5%,0.25W	1
R009	442418	01015	RESISTOR	RES,CF,43K,+-5%,0.25W	1
R010	441501	AI010	RESISTOR	RES,CF,27K,+-5%,0.25W	1
R011	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R012	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R013	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R014	474387	01063	RESISTOR,VAR	RES,VAR,CERMET,500K,+-10%,0.5W	1
R015	305896	AI051	RESISTOR	RES,MF,49.9,+-1%,0.125W,100PPM	1
R016	289454	AI052	RESISTOR	RES,MF,169K,+-1%,0.125W,100PPM	1
R018	377283	01010	8600A-4502-141	ZENER REFERENCE SET	2
R019	377283	01010	8600A-4502-141	ZENER REFERENCE SET	0
R021	289470	AI053	RESISTOR	RES,MF,215K,+-1%,0.125W,100PPM	1
R022	348847	AI011	RESISTOR	RES,CF,12K,+-5%,0.25W	1
R023	235234	AI054	RESISTOR	RES,MF,22.1K,+-1%,0.125W,100PPM	1
R024	340794	AI055	RESISTOR	RES,MF,221,+-1%,0.125W,100PPM	1
R025	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R026	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R027	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R028	348938	AI033	RESISTOR	RES,CF,150K,+-5%,0.25W	1
R030	720995	01071	RESISTOR, VAR	RES,VAR,CERM,500,+-10%,0.5W	1
R031	721001	01061	RESISTOR, VAR	RES,VAR,CERM,25K,+-10%,0.5W	1
R032	268789	01049	RESISTOR	RES,MF,10,+-1%,0.125W,100PPM	1
R033	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1
R039	375782	01059	RESISTOR	RES,WW,SET,TOL/TC MATCHED	1
R040	375782	01059	RESISTOR	RES,WW,SET,TOL/TC MATCHED	0
R041	375782	01059	RESISTOR	RES,WW,SET,TOL/TC MATCHED	0
R043	221606	01019	RESISTOR	RES,CC,16K,+-5%,0.25W	1
R044	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R045	348920	AI012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R046	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R047	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R048	241083	AI058	RESISTOR	RES,MF,150K,+-1%,0.125W,100PPM	1
R049	381517	AI059	RESISTOR	RES,MF,681K,+-1%,0.125W,100PPM	1
R050	348896	AI013	RESISTOR	RES,CF,47K,+-5%,0.25W	1
R051	241372	01036	RESISTOR	RES,MF,38.3K,+-1%,O.125W,100PPM	1
R052	289074	AI060	RESISTOR	RES,MF,133K,+-1%,0.125W,100PPM	1
R055	368712	AI014	RESISTOR	RES,CF,5.1K,+-5%,0.25W	1
R056	293605	01037	RESISTOR	RES,MF,10.2K,+-1%,0.125W,100PPM	1
R058	376434	AI015	RESISTOR	RES,CF,51K,+-5%,0.25W	1
R059	442400	AI016	RESISTOR	RES,CF,39K,+-5%,0.25W	1
R060	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R065	235283	AI064	RESISTOR	RES,MF,309K,+-1%,0.125W,100PPM	1
R066	442400	AI016	RESISTOR	RES,CF,39K,+-5%,0.25W	1
R067	293472	01043	RESISTOR	RES,MF,100K,+-1%,0.125W,25PPM	1

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R068	288530	AI062	RESISTOR	RES,MF,64.9K,+-1%,0.125W,100PPM	1
R069	706119	AI063	RESISTOR	RES,MF,226K,+-0.1%,0.125W,100PPM	1
R071	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R075	377283	01010	8600A-4502-141	ZENER REFERENCE SET	0
R076	377283	01010	8600A-4502-141	ZENER REFERENCE SET	0
R077	237230	AI057	RESISTOR	RES,MF,61.9K,+-1%,0.125W,100PPM	1
R078	268417	01038	RESISTOR	RES,MF,6.81K,+-1%,0.125W,100PPM	1
R081	461921	01051	RESISTOR	RES,WW,6.2K,+-1%,.125W	1
R082	572792	AI044	RESISTOR	RES,CC,2M,+-5%,0.25W	1
R083	461939	01052	RESISTOR	RES,WW,100,+-1%,.125W	1
R101	109397	01020	RESISTOR	RES,CC,100K,+-10%,1W	1
R102	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1
R103	342618	AI017	RESISTOR	RES,CF,56,+-5%,0.25W	1
R104	368779	AI019	RESISTOR	RES,CF,680,+-5%,0.25W	1
R105	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R106	442350	AI038	RESISTOR	RES,CF,5.6K,+-5%,0.25W	1
R107	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R108	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R109	441436	01045	RESISTOR	RES,CF,180,+-5%,0.25W	1
R110	193045	01065	RESISTOR,VAR	RES,VAR,CERM,100K,+-30%,0.5W	1
R111	441477	01032	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R113	573352	AI029	RESISTOR	RES,CF,6.8K,+-5%,0.25W	1
R115	441477	01032	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R116	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R117	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1
R118	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1
R119	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R122	342626	AI018	RESISTOR	RES,CF,220,+-5%,0.25W	1
R123	342626	AI018	RESISTOR	RES,CF,220,+-5%,0.25W	1
R124	161406	01031	RESISTOR	RES,CC,3.9K,+-10%,0.5W	1
R125	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	6
R126	340075	AI030	RESISTOR	RES,CF,10,+-5%,0.25W	1
R127	340075	AI030	RESISTOR	RES,CF,10,+-5%,0.25W	1
R128	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R129	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R130	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R131	260679	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1
R132	260679	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1
R133	348854	AI020	RESISTOR	RES,CF,15K,+-5%,0.25W	1
R134	573675	01016	RESISTOR	RES,CF,470K,+-5%,0.25W	1
R135	234963	AI067	RESISTOR	RES,MF,19.1K,+-1%,0.125W,100PPM	1
R136	294868	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R137	294868	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R138	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R139	168252	AI070	RESISTOR	RES,MF,4.99K,+-1%,0.125W,100PPM	1
R140	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R141	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R142	379040	01046	RESISTOR	RES,MF,9.31K,+-1%,0.125W,100PPM	1
R143	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R144	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R145	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R146	393728	01066	RESISTOR,VAR	RES,VAR,CERM,1K,+-10%,0.5W	1
R148	193060	01064	RESISTOR,VAR	RES,VAR,CERM,1K.+-30%,0.5W	1
R149	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R154	161406	01031	RESISTOR	RES,CC,3.9K,+-10%,0.5W	1
R155	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R156	340075	AI030	RESISTOR	RES,CF,10,+-5%,0.25W	1
R157	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R158	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R159	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R160	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R161	260679	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1

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R162	260679	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1
R163	348854	AI020	RESISTOR	RES,CF,15K,+-5%,0.25W	1
R164	573675	01016	RESISTOR	RES,CF,470K,+-5%,0.25W	1
R165	234963	AI067	RESISTOR	RES,MF,19.1K,+-1%,0.125W,100PPM	1
R166	294868	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R167	294868	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R168	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R169	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R170	168252	AI070	RESISTOR	RES,MF,4.99K,+-1%,0.125W,100PPM	1
R171	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R172	379040	01046	RESISTOR	RES,MF,9.31K,+-1%,0.125W,100PPM	1
R173	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R174	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R175	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R176	393728	01066	RESISTOR,VAR	RES,VAR,CERM,1K,+-10%,0.5W	1
R178	193060	01064	RESISTOR,VAR	RES,VAR,CERM,1K.+-30%,0.5W	1
R179	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R184	441477	01032	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R185	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R186	342626	AI018	RESISTOR	RES,CF,220,+-5%,0.25W	1
R187	441436	01045	RESISTOR	RES,CF,180,+-5%,0.25W	1
R188	342626	AI018	RESISTOR	RES,CF,220,+-5%,0.25W	1
R189	340075	AI030	RESISTOR	RES,CF,10,+-5%,0.25W	1
R190	441477	01032	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R191	193045	01065	RESISTOR,VAR	RES,VAR,CERM,100K,+-30%,0.5W	1
R193	573352	AI029	RESISTOR	RES,CF,6.8K,+-5%,0.25W	1
R194	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R195	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1
R196	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1
R197	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R204	474973	01068	RESISTOR,VAR	RES,VAR,CERM,200,+-10%,0.5W	1
R205	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R207	461988	AI071	RESISTOR	RES,MF,900,+-0.1%,0.125W,50PPM	1
R208	461970	AI072	RESISTOR	RES,MF,90,+-0.1%,0.125W,50PPM	1
R209	461962	01055	RESISTOR	RES,WW,9.000,+-.15%,3W	1
R211	108233	01021	RESISTOR	RES,CC,22M,+-10%,0.5W	1
R212	221986	AI023	RESISTOR	RES,CC,22M,+-5%,0.25W	1
R213	357665	AI024	RESISTOR	RES,CF,1,+-5%,0.25W	1
R214	285056	01022	RESISTOR	RES,CC,100K,+-5%,2W	1
R215	348755	AI025	RESISTOR	RES,CF,15,+-5%,0.25W	1
R218	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R219	478883	01069	RESISTOR,VAR	RES,VAR,CERM,5K,+-10%,0.5W	1
R220	342659	AI026	RESISTOR	RES,CF,2.2M,+-5%,O.25W	1
R221	485052	01070	RESISTOR,VAR	RES,VAR,CERM,1M,+-10%,0.5W	1
R223	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R230	348821	AI028	RESISTOR	RES,CF,4.7K,+-5%,0.25W	1
R231	348920	AI012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R235	187880	01029	RESISTOR	RES,CC,5.6K,+-5%,0.5W	1
R240	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R243	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R244	733469	01054	RESISTOR	RES,WW,25,+-5%,10W	1
R245	344507	AI076	RESISTOR	RES,MF,39.2K,+-0.1%,0.125W,25PPM	1
R246	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R247	733469	01054	RESISTOR	RES,WW,25,+-5%,10W	1
R248	344507	AI076	RESISTOR	RES,MF,39.2K,+-0.1%,0.125W,25PPM	1
R249	441451	AI034	RESISTOR	RES,CF,200,+-5%,0.25W	1
R252	241380	01039	RESISTOR	RES,MF,97.6K,+-1%,0.125W,100PPM	1
R254	344507	AI076	RESISTOR	RES,MF,39.2K,+-0.1%,0.125W,25PPM	1
R255	168286	01048	RESISTOR	RES,MF,30.1K,+-1%,0.125W,100PPM	1
R256	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R257	221663	01047	RESISTOR	RES,MF,9.09K,+-1%,0.125W,100PPM	1
R259	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1

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R260	291393	01033	RESISTOR	RES,MF,33.2K,+-1%,0.125W,100PPM	1
R262	218719	01024	RESISTOR	RES,CC,1.3,+-5%,0.5W	1
R263	109165	01026	RESISTOR	RES,CC,10K,+-5%,0.5W	1
R266	441451	AI034	RESISTOR	RES,CF,200,+-5%,0.25W	1
R268	241380	01039	RESISTOR	RES,MF,97.6K,+-1%,0.125W,100PPM	1
R270	344507	AI076	RESISTOR	RES,MF,39.2K,+-0.1%,0.125W,25PPM	1
R271	168286	01048	RESISTOR	RES,MF,30.1K,+-1%,0.125W,100PPM	1
R272	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R273	221663	01047	RESISTOR	RES,MF,9.09K,+-1%,0.125W,100PPM	1
R275	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1
R276	291393	01033	RESISTOR	RES,MF,33.2K,+-1%,0.125W,100PPM	1
R278	218719	01024	RESISTOR	RES,CC,1.3,+-5%,0.5W	1
R279	109165	01026	RESISTOR	RES,CC,10K,+-5%,0.5W	1
R284	309757	01040	RESISTOR	RES,MF,51.1K,+-1%,0.125W,25PPM	1
R285	309757	01040	RESISTOR	RES,MF,51.1K,+-1%,0.125W,25PPM	1
R286	288522	01041	RESISTOR	RES,MF,511K,+-1%,0.125W,100PPM	1
R287	347070	01042	RESISTOR	RES,MF,18.2K,+-1%,0.125W,50PPM	1
R288	293472	01043	RESISTOR	RES,MF,100K,+-1%,0.125W,25PPM	1
R301	573675	01016	RESISTOR	RES,CF,470K,+-5%,0.25W	1
R302	221986	AI023	RESISTOR	RES,CC,22M,+-5%,0.25W	1
R304	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R305	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R306	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R307	442368	AI035	RESISTOR	RES,CF,6.2K,+-5%,0.25W	1
R309	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R310	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R401	368712	AI014	RESISTOR	RES,CF,5.1K,+-5%,0.25W	1
R402	368712	AI014	RESISTOR	RES,CF,5.1K,+-5%,0.25W	1
R403	291872	AI075	RESISTOR	RES,MF,20K,+-1%,0.125W,100PPM	1
R404	229146	AI074	RESISTOR	RES,MF,1.21K,+-1%,0.125W,100PPM	1
R405	170704	01025	RESISTOR	RES,CC,910,+-5%,0.5W	1
R406	348771	AI022	RESISTOR	RES,CF,100,+-5%,0.25W	1
R407	572594	AI045	RESISTOR	RES,CC,68,+-5%,0.25W	1
R408	348763	AI032	RESISTOR	RES,CF,27,+-5%,0.25W	1
R409	241471	01044	RESISTOR	RES,MF,27.4K,+-1%,0.125W,100PPM	1
R410	268417	01038	RESISTOR	RES,MF,6.81K,+-1%,0.125W,100PPM	1
R411	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R412	109389	01030	RESISTOR	RES,CC,10K,+-10%,1W	1
R413	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R414	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R415	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R416	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R417	159616	01028	RESISTOR	RES,CC,270,+-5%,0.5W	1
R418	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R419	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R420	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R421	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R422	159616	01028	RESISTOR	RES,CC,270,+-5%,0.5W	1
R423	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R424	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R425	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R426	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R427	159616	01028	RESISTOR	RES,CC,270,+-5%,0.5W	1
R430	109124	01027	RESISTOR	RES,CC,560,+-5%,0.5W	1
R431	659060	01053	RESISTOR	RES,WW,.04,+-10%,2W	1
R432	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R433	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R434	393728	01066	RESISTOR,VAR	RES,VAR,CERM,1K,+-10%,0.5W	1
RT201	446849	01075	THERMISTOR	THERMISTOR,RECT.,POS.,1K,+-40%,25C	1
RV201	447672	01073	VARISTOR	VARISTOR,430V,+-10%,1.0MA	1
RV202	447672	01073	VARISTOR	VARISTOR,430V,+-10%,1.0MA	1
RV203	447672	01073	VARISTOR	VARISTOR,430V,+-10%,1.0MA	1

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S401	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
S402	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
S403	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
S404	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
T001	775049	01005	A21-50-6301	INVERTER TRANSFORMER	1
T002	775056	01006	A21-50-6302	INVERTER TRANSFORMER	1
T003	735092	01007	A21-50-6303	TRANSFORMER	1
T004	735100	01008	A21-50-6304	HF POWER TRANSFORMER	1
TP001	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	8
TP002	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP003	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP004	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP005	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP006	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP007	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP008	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP009	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP010	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP011	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP012	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP013	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP015	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP016	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP017	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP018	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP019	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP101	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP102	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP201	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP202	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP203	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP205	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP207	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP301	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP302	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
U001	352195	AI090	BIPOLAR 311	IC,COMPARATOR,8 PIN DIP	1
U002	429837	01171	BIFET LF356B	IC,OP AMP,JFET INPUT,TO-5 CASE	1
U003	473389	AI097	CMOS 74C906	IC,CMOS,HEX OPEN DRAIN BUFFER	1
U006	472779	AI091	BIFET LF356N	IC,OP AMP,JFET INPUT,8 PIN DIP	1
U008	685164	AI092	BIFET LF412	IC,OP AMP,DUAL,LO OFFST,VOLT,LO-DRIFT	1
U011	413179	01173	BIPOLAR 7915	IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS	1
U012	413187	01174	BIPOLAR 7815	IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS	1
U013	428847	01175	BIPOLAR 7805	IC,VOLT REG,FIXED,+5 VOLTS,1.5 AMPS	1
U014	387233	AI094	BIPOLAR 339	IC,COMPARATOR,QUAD,14 PIN DIP	1
U020	413740	01172	BIPOLAR LM307	IC,OP AMP,GENERAL PURPOSE,8 PIN DIP	1
U021	225961	01176	BIPOLAR AD8023	IC,OP AMP,SELECTED,GEN PURPOSE,TO-78	1
U101	643098	AI098	CMOS 7207A	IC,CMOS,OSCILLATOR CONTROLLER	1
U102	403568	AI099	CMOS 4017B	IC,CMOS,DIV BY 10CNTR W/10DECODED OUT	1
U103	393058	AI100	LSTTL 74LS04	IC,LSTTL,HEX INVERTER	1
U104	404681	AI101	CMOS 4069UB	IC,CMOS,HEX INVERTER	1
U105	355198	AI102	CMOS 4011UB	IC,CMOS,QUAD 2 INPUT NAND GATE	1
U107	428847	01175	BIPOLAR 7805	IC,VOLT REG,FIXED,+5 VOLTS,1.5 AMPS	1
U108	872812	01178	A21-44-7609K	KIT, AMPLIFIER REPLACEMENT FOR 643072	1
U109	643080	01177	BIPOLAR 8038	IC,BPLR,WAVE FORM GENERATOR/VCO	1
U110	392902	01179	BIPOLAR LM1436	IC,OP AMP,GEN PURPOSE,COMPENSATD,TO-5	1
U111	429837	01171	BIFET LF356B	IC,OP AMP,JFET INPUT,TO-5 CASE	1
U112	872812	01178	A21-44-7609K	KIT, AMPLIFIER REPLACEMENT FOR 643072	1
U113	643080	01177	BIPOLAR 8038	IC,BPLR,WAVE FORM GENERATOR/VCO	1
U114	429837	01171	BIFET LF356B	IC,OP AMP,JFET INPUT,TO-5 CASE	1
U115	392902	01179	BIPOLAR LM1436	IC,OP AMP,GEN PURPOSE,COMPENSATD,TO-5	1
U116	460410	01170	BIPOLAR 317	IC,VOLT REG,ADJ,1.2 TO 37 V,1.5 AMPS	1
U117	707661	01169	BIPOLAR LM337	IC,VOLT REG,ADJ,NEG,-1.2VTO-37V.	1

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U118	460410	01170	BIPOLAR 317		IC,VOLT REG,ADJ,1.2 TO 37 V,1.5 AMPS	1
U119	707661	01169	BIPOLAR LM337		IC,VOLT REG,ADJ,NEG,-1.2VT0-37V.	1
U120	855135	01186	BIPOLAR OPA541B		IC,OP AMP,VS=+-40 V	1
U121	855135	01186	BIPOLAR OPA541B		IC,OP AMP,VS=+-40 V	1
U201	480897	01012	53-5026	X	HYBRID RMS CONVERTER	1
U202	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U203	418780	AI096	BIFET LF351		IC,OP AMP,JFET IN,COMPENSTD,8 PIN DIP	1
U207	418582	01184	DIODE,RECT,BRIDGE		DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	1
U251	685164	AI092	BIFET LF412		IC,OP AMP,DUAL,LO OFFST,VOLT,LO-DRIFT	1
U252	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U253	685164	AI092	BIFET LF412		IC,OP AMP,DUAL,LO OFFST,VOLT,LO-DRIFT	1
U254	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U255	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U256	418566	AI093	BIPOLAR LM358		IC,OP AMP,SELECTED GBW 600KHZ	1
U301	507640	AI106	CMOS 4060B		IC,CMOS,14STAGE RIPPLE CARRY BIN CNTR	1
U302	393041	AI089	LSTTL 74LS02		IC,LSTTL,QUAD 2 INPUT NOR GATE	1
U303	504449	AI104	LSTTL 74LS132		IC,LSTTL,QUAD 2 IN NAND W/SCHMT TRIG	1
U304	340125	AI103	CMOS 4015B		IC,CMOS,DUAL 4BIT SER-IN,PAR-OUT SHFT	1
U305	412999	AI107	LSTTL 74LS109		IC,LSTTL,DUAL J-K F/F,+EDG TRIG	1
U306	428847	01175	BIPOLAR 7805		IC,VOLT REG,FIXED,+5 VOLTS,1.5 AMPS	1
U401	454678	AI108	BIPOLAR 3524		IC,REGULATING PULSE WIDTH MODULATOR	1
U402	355172	AI105	CMOS 4001B		IC,CMOS,QUAD 2 INPUT NOR GATE	1
U403	340117	AI088	CMOS 4013B		IC,CMOS,DUAL D F/F,+EDG TRIG	1
U404	381830	AI087	CMOS 4050B		IC,CMOS,HEX BUFFER	1
VR001	377283	01010	8600A-4502-141		ZENER REFERENCE SET	0
VR004	181073	01148	ZENER 1N969B		ZENER,UNCOMP,22.0V,5%,5.6MA,0.4W	1
VR013	348482	01139	DIODE,FET,CURRENT		DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	1
VR014	348482	01139	DIODE,FET,CURRENT		DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	1
VR019	393579	01140	ZENER 1N4567		ZENER,COMP,6.4V,2%,2PPM,0.5MA	1
VR075	377283	01010	8600A-4502-141		ZENER REFERENCE SET	0
VR110	357848	01142	ZENER		ZENER,COMP,6.35V,4%,10PPM,2MA	1
VR111	357848	01142	ZENER		ZENER,COMP,6.35V,4%,10PPM,2MA	1
VR122	357848	01142	ZENER		ZENER,COMP,6.35V,4%,10PPM,2MA	1
VR123	357848	01142	ZENER		ZENER,COMP,6.35V,4%,10PPM,2MA	1
VR202	180455	01147	ZENER 1N749A		ZENER,UNCOMP,4.3V,5%,20.0MA,0.4W	1
VR301	277236	01136	ZENER 1N752A		ZENER,UNCOMP,5.6V,5%,20.0MA,0.4W	1
VR402	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR403	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR404	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR405	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR406	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR407	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR408	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR409	186163	AI084	ZENER 1N974B		ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	1
VR410	650358	01149	ZENER 1N5646		ZENER,TRANS SUPPRESSOR,36V,10%	1
XU108	291534	01205	SOCKET		SOCKET,IC,16 PIN	1
XU112	291534	01205	SOCKET		SOCKET,IC,16 PIN	1
Y001	474072	01195	CRYSTAL		CRYSTAL,4MHZ,+-0.02%,HC-18/U W/SLEEVE	1
Y101	643056	01196	CRYSTAL		CRYSTAL,5.24288MHZ,+-0.01%,HC-18/U	1
Y301	519173	01197	CRYSTAL		CRYSTAL,38.4KHZ,+-0.01%,3X8 OR 2X6 MM	1
Z005	413286	01078	RESISTOR		RES,CERM,SIP,8 PIN,7 RES,47K,+-2%	1
Z204	474999	01081	RESISTOR		RES,CERM,NET,CUSTOM	1
Z205	461491	01080	RESISTOR		RES,WW,NET,TOL MATCHED	1
Z206	508762	01079	54-4043T		RES NET ASSY TESTED (8010 DIVIDER)	1

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F	369819	01074	FUSE	FUSE,.25X1.25,1A,250V,FAST	1
H	740738	01199	HEAT DISSIPATOR	HEAT DIS,HORIZ,1.860,1.062,.500,TO-3	2
H	524934	01201	HEAT DISSIPATOR	HEAT DIS,VERT,1.25X.875X.25,TO-220	3
H	386235	01202	HEAT DISSIPATOR	HEAT DIS,PWB MTG,1.380,2.000,.500	2
H	370304	01204	SOCKET	SOCKET,IC,14 PIN	2
H	429282	01206	SOCKET	SOCKET,IC,40 PIN	1
H	520189	01211	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,20 POS	7
H	745869	01215	RIVET	RIVET,PUSH,BI,NYL,0.118X0.217	5
H	146225	01217	WASHER	WASHER,FLAT,SS,.125,.317,.030	5
H	155473	01218	SPACER	SPACER,.250 RND,CERAMIC,.135,.500	4
H	285346	01219	SPACER	SPACER,SWITCH STANDOFF,POLY-E,.063	2
H	393785	01220	NUT	NUT,BROACH,STL,6-32	7
H	328047	01221	SPACER	SPACER,SWAGE,.250 HEX,BR,6-32,.188	4
H	177022	01222	SCREW	SCREW,PH,P,SEMS,STL,6-32,.375	4
H	561431	01224	FUSE CLIP	FUSE CLIP,PCB,1/4X1-1/4	2
MP	515635	01014	8050A-2007	SUPPORT, HYBRID	2
MP	873245	01226	A21-44-2014	DECAL, PATENT 4445111 IDENTIFICATION	1
MP	718411	10001	A21-50-3001	PCB, MAIN BOARD	1
C001	148536	01086	CAPACITOR	CAP,MICA,47PF,+-5%,500V	1
C002	364042	01087	CAPACITOR	CAP,POLYPR,0.47UF,+-5%,50V,HERMETIC	1
C003	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C004	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C005	106732	01093	CAPACITOR	CAP,CER,0.0012UF,+-10%,500V,Z5R	1
C006	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C007	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C008	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C009	614024	01089	CAPACITOR	CAP,AL,15UF,+-20%,35V	1
C010	306522	01094	CAPACITOR	CAP,POLYCA,2.2UF,+-10%,100V	1
C011	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C012	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C013	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C014	330662	01088	CAPACITOR	CAP,TA,10UF,+-20%,20V	1
C015	330662	01088	CAPACITOR	CAP,TA,10UF,+-20%,20V	1
C016	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C017	177980	01095	CAPACITOR	CAP,MICA,430PF,+-5%,500V	1
C018	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C020	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C023	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C024	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C025	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C026	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C027	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C028	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C029	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C030	162008	01097	CAPACITOR	CAP,POLYES,0.047UF,+-10%,250V	1
C031	161919	01133	CAPACITOR	CAP,TA,1UF,+-10%,35V	1
C032	161919	01133	CAPACITOR	CAP,TA,1UF,+-10%,35V	1
C034	161919	01133	CAPACITOR	CAP,TA,1UF,+-10%,35V	1
C035	309849	01098	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C036	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C037	306522	01094	CAPACITOR	CAP,POLYCA,2.2UF,+-10%,100V	1
C038	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C040	369124	01100	CAPACITOR	CAP,POLYES,0.47UF,+-10%,100V	1
C041	160317	01099	CAPACITOR	CAP,MICA,33PF,+-5%,500V	1
C101	175224	01122	CAPACITOR	CAP,MICA,12PF,+-5%,500V	1
C102	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C103	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C104	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C105	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C106	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C107	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C108	148551	01123	CAPACITOR	CAP,MICA,22PF,+-5%,500V	1

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C109	404301	01102	CAPACITOR	CAP,VAR,6-50PF,250V,CER	1
C111	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C112	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C113	175216	01121	CAPACITOR	CAP,MICA,10PF,+-10%,500V	1
C114	355420	01132	CAPACITOR	CAP,CER,0.05UF,+80-20%,1000V,Z5U	1
C115	355420	01132	CAPACITOR	CAP,CER,0.05UF,+80-20%,1000V,Z5U	1
C118	739987	01126	CAPACITOR	CAP,POLYES,4700PF,+-5%,50V	1
C119	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C120	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C121	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C124	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C125	354852	01106	CAPACITOR	CAP,CER,33PF,+-2%,50V,C0G	1
C126	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C127	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C128	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C129	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C130	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C131	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C135	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C138	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C139	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C140	739987	01126	CAPACITOR	CAP,POLYES,4700PF,+-5%,50V	1
C141	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C142	354852	01106	CAPACITOR	CAP,CER,33PF,+-2%,50V,C0G	1
C143	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C144	641225	01107	CAPACITOR	CAP,AL,100UF,+50-20%,100V	1
C145	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C146	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C147	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C148	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C155	309849	01098	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C156	309849	01098	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C157	528604	01096	CAPACITOR	CAP,CER,820PF,+-5%,100V,C0G	1
C158	528604	01096	CAPACITOR	CAP,CER,820PF,+-5%,100V,C0G	1
C159	436782	01130	CAPACITOR	CAP,CER,1UF,+-20%,50V,Z5U	1
C160	436782	01130	CAPACITOR	CAP,CER,1UF,+-20%,50V,Z5U	1
C161	436782	01130	CAPACITOR	CAP,CER,1UF,+-20%,50V,Z5U	1
C162	436782	01130	CAPACITOR	CAP,CER,1UF,+-20%,50V,Z5U	1
C163	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C164	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C165	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C201	435016	01109	CAPACITOR	CAP,VAR,0.25-1.5PF,1700V,TEFLON	1
C202	148452	01127	CAPACITOR	CAP,MICA,270PF,+-5%,500V	1
C203	148478	01108	CAPACITOR	CAP,MICA,150PF,+-5%,500V	1
C204	435016	01109	CAPACITOR	CAP,VAR,0.25-1.5PF,1700V,TEFLON	1
C205	192518	01128	CAPACITOR	CAP,MICA,3300PF,+-2%,500V	1
C206	162008	01097	CAPACITOR	CAP,POLYES,0.047UF,+-10%,250V	1
C207	148478	01108	CAPACITOR	CAP,MICA,150PF,+-5%,500V	1
C208	193623	01110	CAPACITOR	CAP,TA,10UF,+-20%,15V	1
C209	448183	01111	CAPACITOR	CAP,POLYES,0.022UF,+-10%,1000V	1
C210	436840	01112	CAPACITOR	CAP,AL,22UF,+50-20%,35V	1
C211	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C216	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C218	161927	01114	CAPACITOR	CAP,TA,2.2UF,+-20%,20V	1
C219	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C229	330662	01088	CAPACITOR	CAP,TA,10UF,+-20%,20V	1
C230	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C231	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C232	603977	01091	CAPACITOR	CAP,AL,47UF,+-20%,35V	1
C233	193623	01110	CAPACITOR	CAP,TA,10UF,+-20%,15V	1
C234	149153	01113	CAPACITOR	CAP,CER,0.01UF,+80-20%,100V,Z5V	1
C236	148494	01129	CAPACITOR	CAP,MICA,100PF,+-5%,500V	1

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C248	148924	01103	CAPACITOR	CAP,CER,0.05UF,+80-20%,25V,Y5U	1
C249	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C250	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C251	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C252	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C253	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C254	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C255	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C256	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C257	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C258	175232	01085	CAPACITOR	CAP,CER,5000PF,+-20%,100V,Z5V	1
C259	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C260	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C261	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C262	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C263	148924	01103	CAPACITOR	CAP,CER,0.05UF,+80-20%,25V,Y5U	1
C264	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C265	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C266	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C267	614362	01115	CAPACITOR	CAP,AL,22UF,+-20%,50V	1
C269	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C270	148924	01103	CAPACITOR	CAP,CER,0.05UF,+80-20%,25V,Y5U	1
C271	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C301	175216	01121	CAPACITOR	CAP,MICA,10PF,+-10%,500V	1
C302	404301	01102	CAPACITOR	CAP,VAR,6-50PF,250V,CER	1
C304	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C305	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C306	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C309	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C310	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C311	603985	01090	CAPACITOR	CAP,AL,10UF,+-20%,35V	1
C312	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C313	602342	01092	CAPACITOR	CAP,AL,1UF,+-20%,50V,SOLV PROOF	1
C314	368613	01124	CAPACITOR	CAP,CER,470PF,+-10%,1000V,Z5F	1
C401	512657	01116	CAPACITOR	CAP,AL,190UF,+100-10%,100V	1
C402	309849	01098	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C403	148387	01125	CAPACITOR	CAP,MICA,1000PF,+-5%,500V	1
C404	436113	01120	CAPACITOR	CAP,POLYES,0.22UF,+-10%,100V	1
C405	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C406	494575	01118	CAPACITOR	CAP,AL,470UF,+100-10%,25V	1
C407	393439	01119	CAPACITOR	CAP,POLYES,0.1UF,+-10%,100V	1
C408	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C409	519157	01101	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C410	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C411	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C412	448449	01134	CAPACITOR	CAP,CER,22PF,+-5%,50V,C0G	1
C413	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C414	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C415	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C416	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C417	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C418	407361	01117	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
CR015	203323	AI081	DIODE 1N4448	DIODE,SI,BV= 75.0V,IO=150MA,500MW	1
CR016	203323	AI081	DIODE 1N4448	DIODE,SI,BV= 75.0V,IO=150MA,500MW	1
CR017	203323	AI081	DIODE 1N4448	DIODE,SI,BV= 75.0V,IO=150MA,500MW	1
CR018	203323	AI081	DIODE 1N4448	DIODE,SI,BV= 75.0V,IO=150MA,500MW	1
CR020	203323	AI081	DIODE 1N4448	DIODE,SI,BV= 75.0V,IO=150MA,500MW	1
CR025	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR026	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR027	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR028	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR029	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1

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CR030	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR101	381806	01141	DIODE 1N3062	DIODE,SI,BV= 50.0V,IO= 50MA,250 MW	1
CR102	381806	01141	DIODE 1N3062	DIODE,SI,BV= 50.0V,IO= 50MA,250 MW	1
CR104	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR105	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR106	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR107	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR108	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR109	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR110	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR111	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR112	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR113	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR114	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR115	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR116	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR117	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR118	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR119	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR120	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR121	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR122	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR123	707075	01136	DIODE 1N4007	DIODE,SI,1K PIV,1.0 AMP	1
CR124	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR125	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR126	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR127	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR128	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR129	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR130	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR131	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR201	347559	01144	DIODE	DIODE,SI,50 PIV,2 AMP,SELECTED IR	1
CR202	348177	01145	DIODE	DIODE,SI,BV=20V,IO=50MA,SELECTED IR	1
CR203	348177	01145	DIODE	DIODE,SI,BV=20V,IO=50MA,SELECTED IR	1
CR209	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR210	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR211	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR251	203323	AI081	DIODE 1N4448	DIODE,SI,BV= 75.0V,IO=150MA,500MW	1
CR252	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR253	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR254	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR255	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR256	203323	AI081	DIODE 1N4448	DIODE,SI,BV= 75.0V,IO=150MA,500MW	1
CR257	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR258	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR259	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR260	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR262	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR263	379412	01137	DIODE 1N4933	DIODE,SI,50 PIV,1.0 AMP	1
CR264	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR265	495739	01143	DIODE	DIODE,SI,100 PIV,2.5 AMP	1
CR301	483701	01146	DIODE	DIODE,SI,100 PIV,5.0 AMP	1
CR401	483701	01146	DIODE	DIODE,SI,100 PIV,5.0 AMP	1
J003	631309	01210	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,72 POS	1
J006	631309	01210	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,72 POS	1
J007	520148	01212	CONNECTOR	CONN,PWB EDGE,REC,.100CTR,44 POS	1
JR301	495507	01203	JUMPER	JUMPER,DIP,.300CTR,PROGRAM,8POS	1
L101	461533	01188	INDUCTOR	INDUCTOR,560UH,+-5%,6MHZ,SHLD	1
L102	461533	01188	INDUCTOR	INDUCTOR,560UH,+-5%,6MHZ,SHLD	1
L252	174755	01190	INDUCTOR	INDUCTOR,100UH,+-5%,12MHZ,SHLD	1
L401	490888	01009	2030A-6402	CHOKE	1
P010	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1

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P011	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P013	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P017	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P019	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P020	631168	01209	HEADER	HEADER,1 ROW,.100CTR,9 PIN	1
P021	631176	01208	HEADER	HEADER,1 ROW,.100CTR,6 PIN	1
P022	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P023	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P024	380022	01214	HEADER	HEADER,1 ROW,.156CTR,3 PIN	1
P029	631184	01207	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
Q005	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q006	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q007	419283	01157	JFET,DUAL,N-CHAN	TRANSISTOR,SI,N-JFET,DUAL,TO-71	1
Q008	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q009	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q010	429977	01154	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,REMOTE CUTOFF	1
Q011	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q013	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q014	476911	01011	2180A-4501	DUAL FET,SELECTED OFFSET	1
Q015	376475	01156	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q016	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q017	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q023	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q024	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q025	343830	01158	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,TO-92	1
Q101	403634	01159	JFET,N-CHANNEL	TRANSISTOR,SI,N-JFET,UHF/VHF USE	1
Q104	685453	01162	PNP,POWER TIP30C	TRANSISTOR,SI,BV=100V, 2W,TO-220	1
Q105	685446	01161	NPN,POWER TIP31C	TRANSISTOR,SI,BV=100V, 40W,TO-220	1
Q108	685446	01161	NPN,POWER TIP31C	TRANSISTOR,SI,BV=100V, 40W,TO-220	1
Q109	685453	01162	PNP,POWER TIP30C	TRANSISTOR,SI,BV=100V, 2W,TO-220	1
Q201	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q202	218396	01155	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
Q205	195974	01163	PNP 2N3906	TRANSISTOR,SI,PNP,SMALL SIGNAL	1
Q251	741538	01167	NPN STS1018	TRANSISTOR,SI,NPN,TEMP SENSOR TO-92	1
Q252	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q253	741538	01167	NPN STS1018	TRANSISTOR,SI,NPN,TEMP SENSOR TO-92	1
Q254	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q255	381731	01164	NPN,POWER MPSU10	TRANSISTOR,SI,BV=300V, 10W,TO-202	1
Q257	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q258	386128	01153	NPN,POWER TIP120	TRANSISTOR,SI,BV= 60V, 65W,TO-220	1
Q401	325753	01165	PNP,POWER D45C5	TRANSISTOR,SI,BV=45V,27W,TO-220	1
Q403	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q405	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q406	741041	01160	FET,POWER,N,VN0606	TRANSISTOR,SI,NMOS,1W,TO-237	1
Q408	586107	01166	FET,PWR,N,MTP12N08	TRANSISTOR,SI,NMOS,75W,TO-220	1
Q411	586107	01166	FET,PWR,N,MTP12N08	TRANSISTOR,SI,NMOS,75W,TO-220	1
Q412	586107	01166	FET,PWR,N,MTP12N08	TRANSISTOR,SI,NMOS,75W,TO-220	1
Q415	586107	01166	FET,PWR,N,MTP12N08	TRANSISTOR,SI,NMOS,75W,TO-220	1
Q416	586107	01166	FET,PWR,N,MTP12N08	TRANSISTOR,SI,NMOS,75W,TO-220	1
Q419	586107	01166	FET,PWR,N,MTP12N08	TRANSISTOR,SI,NMOS,75W,TO-220	1
R002	110015	01018	RESISTOR	RES,CC,47K,+-10%,2W	1
R003	479030	01058	RESISTOR	RES,MF,SET,TC MATCHED	1
R004	479030	01058	RESISTOR	RES,MF,SET,TC MATCHED	0
R005	275743	01062	RESISTOR,VAR	RES,VAR,CERM,200,+-10%,0.5W	1
R006	573170	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R008	348813	AI008	RESISTOR	RES,CF,3.3K,+-5%,0.25W	1
R009	442418	01015	RESISTOR	RES,CF,43K,+-5%,0.25W	1
R010	441501	AI010	RESISTOR	RES,CF,27K,+-5%,0.25W	1
R011	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R012	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R013	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R014	474387	01063	RESISTOR,VAR	RES,VAR,CERMET,500K,+-10%,0.5W	1

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R015	720318	AI051	RESISTOR	RES,MF,49.9,+-1%,0.125W,100PPM	1
R016	719732	AI052	RESISTOR	RES,MF,169K,+-1%,0.125W,100PPM	1
R018	377283	01010	8600A-4502-141	ZENER REFERENCE SET	2
R019	377283	01010	8600A-4502-141	ZENER REFERENCE SET	0
R021	719864	AI053	RESISTOR	RES,MF,215K,+-1%,0.125W,100PPM	1
R022	348847	AI011	RESISTOR	RES,CF,12K,+-5%,0.25W	1
R023	719898	AI054	RESISTOR	RES,MF,22.1K,+-1%,0.125W,100PPM	1
R024	719872	AI055	RESISTOR	RES,MF,221,+-1%,0.125W,100PPM	1
R025	573170	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R026	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R027	352245	AI056	RESISTOR	RES,MF,10.02K,+-0.1%,0.125W,50PPM	1
R028	573600	AI033	RESISTOR	RES,CF,150K,+-5%,0.25W	1
R030	720995	01071	RESISTOR, VAR	RES,VAR,CERM,500,+-10%,0.5W	1
R031	721001	01061	RESISTOR, VAR	RES,VAR,CERM,25K,+-10%,0.5W	1
R032	268789	01049	RESISTOR	RES,MF,10,+-1%,0.125W,100PPM	1
R033	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1
R039	375782	01059	RESISTOR	RES,WW,SET,TOL/TC MATCHED	1
R040	375782	01059	RESISTOR	RES,WW,SET,TOL/TC MATCHED	0
R041	375782	01059	RESISTOR	RES,WW,SET,TOL/TC MATCHED	0
R043	221606	01019	RESISTOR	RES,CC,16K,+-5%,0.25W	1
R044	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R045	348920	AI012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R046	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R047	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R048	241083	AI058	RESISTOR	RES,MF,150K,+-1%,0.125W,100PPM	1
R049	720482	AI059	RESISTOR	RES,MF,681K,+-1%,0.125W,100PPM	1
R050	348896	AI013	RESISTOR	RES,CF,47K,+-5%,0.25W	1
R051	241372	01036	RESISTOR	RES,MF,38.3K,+-1%,O.125W,100PPM	1
R052	719609	AI060	RESISTOR	RES,MF,133K,+-1%,0.125W,100PPM	1
R055	368712	AI014	RESISTOR	RES,CF,5.1K,+-5%,0.25W	1
R056	293605	01037	RESISTOR	RES,MF,10.2K,+-1%,0.125W,100PPM	1
R058	376434	AI015	RESISTOR	RES,CF,51K,+-5%,0.25W	1
R059	573501	AI016	RESISTOR	RES,CF,39K,+-5%,0.25W	1
R060	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R065	235283	AI064	RESISTOR	RES,MF,309K,+-1%,0.125W,100PPM	1
R066	573501	AI016	RESISTOR	RES,CF,39K,+-5%,0.25W	1
R067	293472	01043	RESISTOR	RES,MF,100K,+-1%,0.125W,25PPM	1
R068	288530	AI062	RESISTOR	RES,MF,64.9K,+-1%,0.125W,100PPM	1
R069	706119	AI063	RESISTOR	RES,MF,226K,+-0.1%,0.125W,100PPM	1
R071	573170	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R075	377283	01010	8600A-4502-141	ZENER REFERENCE SET	0
R076	377283	01010	8600A-4502-141	ZENER REFERENCE SET	0
R077	237230	AI057	RESISTOR	RES,MF,61.9K,+-1%,0.125W,100PPM	1
R078	268417	01038	RESISTOR	RES,MF,6.81K,+-1%,0.125W,100PPM	1
R081	461921	01051	RESISTOR	RES,WW,6.2K,+-1%,.125W	1
R082	572792	AI044	RESISTOR	RES,CC,2M,+-5%,0.25W	1
R083	461939	01052	RESISTOR	RES,WW,100,+-1%,.125W	1
R101	109397	01020	RESISTOR	RES,CC,100K,+-10%,1W	1
R102	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1
R103	342618	AI017	RESISTOR	RES,CF,56,+-5%,0.25W	1
R104	573154	AI019	RESISTOR	RES,CF,680,+-5%,0.25W	1
R105	348789	AI037	RESISTOR	RES,CF,270,+-5%,0.25W	1
R106	442350	AI038	RESISTOR	RES,CF,5.6K,+-5%,0.25W	1
R107	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R108	573170	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R109	441436	01045	RESISTOR	RES,CF,180,+-5%,0.25W	1
R110	193045	01065	RESISTOR,VAR	RES,VAR,CERM,100K,+-30%,0.5W	1
R111	697110	01032	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R115	441477	AI036	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R116	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R117	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1
R118	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1

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R119	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R120	267666	01023	RESISTOR	RES,CC,2.2,+-5%,0.5W	1
R121	267666	01023	RESISTOR	RES,CC,2.2,+-5%,0.5W	1
R124	161406	01031	RESISTOR	RES,CC,3.9K,+-10%,0.5W	1
R126	442095	AI030	RESISTOR	RES,CF,3.9,+-5%,0.25W	1
R129	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R130	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R131	720276	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1
R132	720276	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1
R133	348854	AI020	RESISTOR	RES,CF,15K,+-5%,0.25W	1
R134	342634	01016	RESISTOR	RES,CF,470K,+-5%,0.25W	1
R135	234963	AI067	RESISTOR	RES,MF,19.1K,+-1%,0.125W,100PPM	1
R136	720342	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R137	720342	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R138	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R139	168252	AI070	RESISTOR	RES,MF,4.99K,+-1%,0.125W,100PPM	1
R140	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R141	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R142	379040	AI01046	RESISTOR	RES,MF,9.31K,+-1%,0.125W,100PPM	1
R143	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R144	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R145	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R146	393728	01066	RESISTOR,VAR	RES,VAR,CERM,1K,+-10%,0.5W	1
R148	193060	01064	RESISTOR,VAR	RES,VAR,CERM,1K.+-30%,0.5W	1
R149	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R154	161406	01031	RESISTOR	RES,CC,3.9K,+-10%,0.5W	1
R157	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R159	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R160	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R161	720276	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1
R162	720276	AI066	RESISTOR	RES,MF,4.75K,+-1%,0.125W,100PPM	1
R163	348854	AI020	RESISTOR	RES,CF,15K,+-5%,0.25W	1
R164	342634	01016	RESISTOR	RES,CF,470K,+-5%,0.25W	1
R165	234963	AI067	RESISTOR	RES,MF,19.1K,+-1%,0.125W,100PPM	1
R166	720342	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R167	720342	AI068	RESISTOR	RES,MF,5.11K,+-1%,0.125W,100PPM	1
R168	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R169	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R170	168252	AI070	RESISTOR	RES,MF,4.99K,+-1%,0.125W,100PPM	1
R171	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R172	379040	01046	RESISTOR	RES,MF,9.31K,+-1%,0.125W,100PPM	1
R173	168229	AI050	RESISTOR	RES,MF,1K,+-1%,0.125W,100PPM	1
R174	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R175	381921	01067	RESISTOR,VAR	RES,VAR,CERM,200K,+-10%,0.5W	1
R176	393728	01066	RESISTOR,VAR	RES,VAR,CERM,1K,+-10%,0.5W	1
R178	193060	01064	RESISTOR,VAR	RES,VAR,CERM,1K.+-30%,0.5W	1
R179	272153	AI069	RESISTOR	RES,MF,43.2K,+-1%,0.125W,100PPM	1
R184	697110	01032	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R185	385948	AI039	RESISTOR	RES,CF,560,+-5%,0.25W	1
R187	441436	01045	RESISTOR	RES,CF,180,+-5%,0.25W	1
R189	442095	AI030	RESISTOR	RES,CF,3.9,+-5%,0.25W	1
R190	441477	AI036	RESISTOR	RES,CF,20K,+-5%,0.25W	1
R191	193045	01065	RESISTOR,VAR	RES,VAR,CERM,100K,+-30%,0.5W	1
R194	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R195	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1
R196	289983	01035	RESISTOR	RES,MF,2.61K,+-1%,0.125W,100PPM	1
R197	328005	01034	RESISTOR	RES,MF,237,+-1%,0.125W,100PPM	1
R198	267666	01023	RESISTOR	RES,CC,2.2,+-5%,0.5W	1
R199	267666	01023	RESISTOR	RES,CC,2.2,+-5%,0.5W	1
R204	474973	01068	RESISTOR,VAR	RES,VAR,CERM,200,+-10%,0.5W	1
R205	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R207	461988	AI071	RESISTOR	RES,MF,900,+-0.1%,0.125W,50PPM	1

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R208	461970	AI072	RESISTOR	RES,MF,90,+-0.1%,0.125W,50PPM	1
R209	461962	01055	RESISTOR	RES,WW,9.000,+-.15%,3W	1
R211	108233	01021	RESISTOR	RES,CC,22M,+-10%,0.5W	1
R212	221986	AI023	RESISTOR	RES,CC,22M,+-5%,0.25W	1
R213	357665	AI024	RESISTOR	RES,CF,1,+-5%,0.25W	1
R214	285056	01022	RESISTOR	RES,CC,100K,+-5%,2W	1
R215	641043	AI025	RESISTOR	RES,CF,15,+-5%,0.25W	1
R218	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R219	478883	01069	RESISTOR,VAR	RES,VAR,CERM,5K,+-10%,0.5W	1
R220	342659	AI026	RESISTOR	RES,CF,2.2M,+-5%,0.25W	1
R221	485052	01070	RESISTOR,VAR	RES,VAR,CERM,1M,+-10%,0.5W	1
R222	573675	AI027	RESISTOR	RES,CF,470K,+-5%,0.25W	1
R223	348987	AI021	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R230	348821	AI028	RESISTOR	RES,CF,4.7K,+-5%,0.25W	1
R231	348920	AI012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R235	187880	01029	RESISTOR	RES,CC,5.6K,+-5%,0.5W	1
R240	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R243	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R244	733469	01054	RESISTOR	RES,WW,25,+-5%,10W	1
R245	706176	AI076	RESISTOR	RES,MF,39.2K,+-.1%,.125W,25PPM	1
R246	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R247	733469	01054	RESISTOR	RES,WW,25,+-5%,10W	1
R248	706176	AI076	RESISTOR	RES,MF,39.2K,+-.1%,.125W,25PPM	1
R249	441451	AI034	RESISTOR	RES,CF,200,+-5%,0.25W	1
R252	241380	01039	RESISTOR	RES,MF,97.6K,+-1%,0.125W,100PPM	1
R254	706176	AI076	RESISTOR	RES,MF,39.2K,+-.1%,.125W,25PPM	1
R255	168286	01048	RESISTOR	RES,MF,30.1K,+-1%,0.125W,100PPM	1
R256	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R257	221663	01047	RESISTOR	RES,MF,9.09K,+-1%,0.125W,100PPM	1
R259	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1
R260	291393	01033	RESISTOR	RES,MF,33.2K,+-1%,0.125W,100PPM	1
R262	218719	01024	RESISTOR	RES,CC,1.3,+-5%,0.5W	1
R263	109165	01026	RESISTOR	RES,CC,10K,+-5%,0.5W	1
R266	441451	AI034	RESISTOR	RES,CF,200,+-5%,0.25W	1
R268	241380	01039	RESISTOR	RES,MF,97.6K,+-1%,0.125W,100PPM	1
R270	706176	AI076	RESISTOR	RES,MF,39.2K,+-.1%,.125W,25PPM	1
R271	168286	01048	RESISTOR	RES,MF,30.1K,+-1%,0.125W,100PPM	1
R272	168260	AI065	RESISTOR	RES,MF,10K,+-1%,0.125W,100PPM	1
R273	221663	01047	RESISTOR	RES,MF,9.09K,+-1%,0.125W,100PPM	1
R275	572842	01028	RESISTOR	RES,CC,10M,+-5%,0.25W	1
R276	291393	01033	RESISTOR	RES,MF,33.2K,+-1%,0.125W,100PPM	1
R278	218719	01024	RESISTOR	RES,CC,1.3,+-5%,0.5W	1
R279	109165	01026	RESISTOR	RES,CC,10K,+-5%,0.5W	1
R284	309757	01040	RESISTOR	RES,MF,51.1K,+-1%,0.125W,25PPM	1
R285	309757	01040	RESISTOR	RES,MF,51.1K,+-1%,0.125W,25PPM	1
R286	288522	01041	RESISTOR	RES,MF,511K,+-1%,0.125W,100PPM	1
R287	347070	01042	RESISTOR	RES,MF,18.2K,+-1%,0.125W,50PPM	1
R288	293472	01043	RESISTOR	RES,MF,100K,+-1%,0.125W,25PPM	1
R293	226092	01060	RESISTOR,VAR	RES,VAR,CERM,10K,+-20%,0.5W	1
R301	573675	AI027	RESISTOR	RES,CF,470K,+-5%,0.25W	1
R302	221986	AI023	RESISTOR	RES,CC,22M,+-5%,0.25W	1
R304	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R305	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R306	343426	AI006	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R307	573345	AI035	RESISTOR	RES,CF,6.2K,+-5%,0.25W	1
R309	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R310	348839	AI007	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R401	368712	AI014	RESISTOR	RES,CF,5.1K,+-5%,0.25W	1
R402	368712	AI014	RESISTOR	RES,CF,5.1K,+-5%,0.25W	1
R403	291872	AI075	RESISTOR	RES,MF,20K,+-1%,0.125W,100PPM	1
R404	719559	AI074	RESISTOR	RES,MF,1.21K,+-1%,0.125W,100PPM	1
R405	170704	01025	RESISTOR	RES,CC,910,+-5%,0.5W	1

JFPN: 718403
NOUN: A21-50-4001
DESC: MAIN BOARD ASSEMBLY
Rev: J

REFDES	JFPN	GPITM	Noun	Description	OPA
R406	348771	AI022	RESISTOR	RES,CF,100,+-5%,0.25W	1
R407	572594	AI045	RESISTOR	RES,CC,68,+-5%,0.25W	1
R408	641357	AI032	RESISTOR	RES,CF,27,+-5%,0.25W	1
R409	241471	01044	RESISTOR	RES,MF,27.4K,+-1%,0.125W,100PPM	1
R410	268417	01038	RESISTOR	RES,MF,6.81K,+-1%,0.125W,100PPM	1
R411	573550	AI005	RESISTOR	RES,CF,68K,+-5%,0.25W	1
R412	109389	01030	RESISTOR	RES,CC,10K,+-10%,1W	1
R413	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R414	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R418	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R419	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R423	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R424	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R430	109124	01027	RESISTOR	RES,CC,560,+-5%,0.5W	1
R431	659060	01053	RESISTOR	RES,WW,.04,+-10%,2W	1
R432	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R433	348888	AI031	RESISTOR	RES,CF,33K,+-5%,0.25W	1
R434	393728	01066	RESISTOR,VAR	RES,VAR,CERM,1K,+-10%,0.5W	1
RT201	446849	01075	THERMISTOR	THERMISTOR,RECT.,POS.,1K,+-40%,25C	1
RT401	460915	01077	FUSE	FUSE,.095X.28,3A,125V,FAST,AXIAL	1
RT402	460915	01077	FUSE	FUSE,.095X.28,3A,125V,FAST,AXIAL	1
RT403	460915	01077	FUSE	FUSE,.095X.28,3A,125V,FAST,AXIAL	1
RV201	447672	01073	VARISTOR	VARISTOR,430V,+-10%,1.0MA	1
RV202	447672	01073	VARISTOR	VARISTOR,430V,+-10%,1.0MA	1
RV203	447672	01073	VARISTOR	VARISTOR,430V,+-10%,1.0MA	1
S401	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
S402	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
S403	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
S404	733808	01200	SWITCH	SWITCH,PUSHBUTTON,SPST	1
T001	775049	01005	A21-50-6301	INVERTER TRANSFORMER	1
T002	775056	01006	A21-50-6302	INVERTER TRANSFORMER	1
T003	735092	01007	A21-50-6303	TRANSFORMER	1
T004	735100	01008	A21-50-6304	HF POWER TRANSFORMER	1
TP001	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP002	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP003	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP004	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP005	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP006	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP007	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP008	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP009	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP010	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP011	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP012	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP013	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP015	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP016	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP017	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP018	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP019	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP101	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP102	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP103	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP104	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP105	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP106	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP201	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP202	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP203	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP205	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1
TP206	512889	01213	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1

JFPN: 718403
NOUN: A21-50-4001
DESC: MAIN BOARD ASSEMBLY
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REFDES	JFPN	GPITM	Noun		Description	QPA
TP207	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
TP210	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
TP211	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
TP212	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
TP301	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
TP302	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
TP401	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
TP402	512889	01213	TERMINAL		TERM,FASTON,TAB,.110,SOLDER	1
U001	352195	AI090	BIPOLAR 311		IC,COMPARATOR,8 PIN DIP	1
U002	429837	01171	BIFET LF356B		IC,OP AMP,JFET INPUT,TO-5 CASE	1
U003	473389	AI097	CMOS 74C906		IC,CMOS,HEX OPEN DRAIN BUFFER	1
U006	472779	AI091	BIFET LF356N		IC,OP AMP,JFET INPUT,8 PIN DIP	1
U008	685164	AI092	BIFET LF412		IC,OP AMP,DUAL,LO OFFST,VOLT,LO-DRIFT	1
U011	413179	01173	BIPOLAR 7915		IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS	1
U012	413187	01174	BIPOLAR 7815		IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS	1
U013	428847	01175	BIPOLAR 7805		IC,VOLT REG,FIXED,+5 VOLTS,1.5 AMPS	1
U014	387233	AI094	BIPOLAR 339		IC,COMPARATOR,QUAD,14 PIN DIP	1
U020	413740	01172	BIPOLAR LM307		IC,OP AMP,GENERAL PURPOSE,8 PIN DIP	1
U021	225961	01176	BIPOLAR AD8023		IC,OP AMP,SELECTED,GEN PURPOSE,TO-78	1
U101	643098	AI098	CMOS 7207A		IC,CMOS,OSCILLATOR CONTROLLER	1
U102	403568	AI099	CMOS 4017B		IC,CMOS,DIV BY 10CNTR W/10DECODED OUT	1
U103	393058	AI100	LSTTL 74LS04		IC,LSTTL,HEX INVERTER	1
U104	404681	AI101	CMOS 4069UB		IC,CMOS,HEX INVERTER	1
U105	355198	AI102	CMOS 4011UB		IC,CMOS,QUAD 2 INPUT NAND GATE	1
U107	428847	01175	BIPOLAR 7805		IC,VOLT REG,FIXED,+5 VOLTS,1.5 AMPS	1
U109	643080	01177	BIPOLAR 8038		IC,BPLR,WAVE FORM GENERATOR/VCO	1
U110	392902	01179	BIPOLAR LM1436		IC,OP AMP,GEN PURPOSE,COMPENSATD,TO-5	1
U113	643080	01177	BIPOLAR 8038		IC,BPLR,WAVE FORM GENERATOR/VCO	1
U115	392902	01179	BIPOLAR LM1436		IC,OP AMP,GEN PURPOSE,COMPENSATD,TO-5	1
U116	460410	01170	BIPOLAR 317		IC,VOLT REG,ADJ,1.2 TO 37 V,1.5 AMPS	1
U117	707661	01169	BIPOLAR LM337		IC,VOLT REG,ADJ,NEG,-1.2VT0-37V.	1
U118	460410	01170	BIPOLAR 317		IC,VOLT REG,ADJ,1.2 TO 37 V,1.5 AMPS	1
U119	707661	01169	BIPOLAR LM337		IC,VOLT REG,ADJ,NEG,-1.2VT0-37V.	1
U120	855135	01186	BIPOLAR OPA541B		IC,OP AMP,VS=+-40 V	1
U121	855135	01186	BIPOLAR OPA541B		IC,OP AMP,VS=+-40 V	1
U201	480897	01012	53-5026	X	HYBRID RMS CONVERTER	1
U202	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U203	418780	AI096	BIFET LF351		IC,OP AMP,JFET IN,COMPENSTD,8 PIN DIP	1
U207	418582	01184	DIODE,RECT,BRIDGE		DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	1
U251	685164	AI092	BIFET LF412		IC,OP AMP,DUAL,LO OFFST,VOLT,LO-DRIFT	1
U252	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U253	685164	AI092	BIFET LF412		IC,OP AMP,DUAL,LO OFFST,VOLT,LO-DRIFT	1
U254	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U255	472845	01168	BIPOLAR 1403		IC, 2.5 V,40 PPM T.C.,BANDGAP REF	1
U256	418566	AI093	BIPOLAR LM358		IC,OP AMP,SELECTED GBW 600KHZ	1
U301	507640	AI106	CMOS 4060B		IC,CMOS,14STAGE RIPPLE CARRY BIN CNTR	1
U302	393041	AI089	LSTTL 74LS02		IC,LSTTL,QUAD 2 INPUT NOR GATE	1
U303	504449	AI104	LSTTL 74LS132		IC,LSTTL,QUAD 2 IN NAND W/SCHMT TRIG	1
U304	340125	AI103	CMOS 4015B		IC,CMOS,DUAL 4BIT SER-IN,PAR-OUT SHFT	1
U305	412999	AI107	LSTTL 74LS109		IC,LSTTL,DUAL J-K F/F,+EDG TRIG	1
U306	428847	01175	BIPOLAR 7805		IC,VOLT REG,FIXED,+5 VOLTS,1.5 AMPS	1
U401	454678	AI108	BIPOLAR 3524		IC,REGULATING PULSE WIDTH MODULATOR	1
U402	355172	AI105	CMOS 4001B		IC,CMOS,QUAD 2 INPUT NOR GATE	1
U403	340117	AI088	CMOS 4013B		IC,CMOS,DUAL D F/F,+EDG TRIG	1
U404	381830	AI087	CMOS 4050B		IC,CMOS,HEX BUFFER	1
VR001	377283	01010	8600A-4502-141		ZENER REFERENCE SET	0
VR004	181073	01148	ZENER 1N969B		ZENER,UNCOMP,22.0V,5%,5.6MA,0.4W	1
VR013	348482	01139	DIODE,FET,CURRENT		DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	1
VR014	348482	01139	DIODE,FET,CURRENT		DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	1
VR019	393579	01140	ZENER 1N4567		ZENER,COMP,6.4V,2%,2PPM,0.5MA	1
VR075	377283	01010	8600A-4502-141		ZENER REFERENCE SET	0
VR110	357848	01142	ZENER		ZENER,COMP,6.3V,3%,10PPM,2MA	1

JFPN: 718403
NOUN: A21-50-4001
DESC: MAIN BOARD ASSEMBLY
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REFDES	JFPN	GPITM	Noun	Description	OPA
VR111	357848	01142	ZENER	ZENER,COMP,6.3V,3%,10PPM,2MA	1
VR122	357848	01142	ZENER	ZENER,COMP,6.3V,3%,10PPM,2MA	1
VR123	357848	01142	ZENER	ZENER,COMP,6.3V,3%,10PPM,2MA	1
VR202	180455	01147	ZENER 1N749A	ZENER,UNCOMP,4.3V,5%,20.0MA,0.4W	1
VR301	277236	01138	ZENER 1N752A	ZENER,UNCOMP,5.6V,5%,20.0MA,0.4W	1
VR410	650358	01149	ZENER 1N5646	ZENER,TRANS SUPPRESSOR,36V,10%	1
Y001	474072	01195	CRYSTAL	CRYSTAL,4MHZ,+-0.02%,HC-18/U W/SLEEVE	1
Y101	643056	01196	CRYSTAL	CRYSTAL,5.24288MHZ,+-0.01%,HC-18/U	1
Y301	519173	01197	CRYSTAL	CRYSTAL,38.4KHZ,+-0.01%,3X8 OR 2X6 MM	1
Z005	413286	01078	RESISTOR	RES,CERM,SIP,8 PIN,7 RES,47K,+-2%	1
Z204	474999	01081	RESISTOR	RES,CERM,NET,CUSTOM	1
Z205	461491	01080	RESISTOR	RES,WW,NET,TOL MATCHED	1
Z206	508762	01079	54-4043T	RES NET ASSY TESTED (8010 DIVIDER)	1

JFPN: 648634
NOUN: A21-44-4002
DESC: T/C INPUT ASSY
REV: B

REFDES	JFPN	ITM	Noun	Description	OPA
H	380196	014	NUT	NUT,BROACH,STL,4-40	2
H	281196	018	SCREW	SCREW,PH,P SEMS,STL,4-40,.375	2
H	152165	019	SCREW	SCREW,PH,P,LOCK,STL,6-32,.375	2
H	343996	021	SPACER	SPACER,SWAGE,.250 RND,BR,4-40,.070	4
MP	648576	001	A21-44-3002	PCB T/C INPUT	1
MP	648527	002	A21-44-2009	T/C NEGATIVE INPUT	1
MP	648519	003	A21-44-2008	T/C POSITIVE INPUT	1
MP	722074	004	A21-50-8013	INSULATOR, TO-18	1
MP	473561	005	2190A-8003	INSULATOR,THERMOCOUPLE INPUT	1
C001	148478	010	CAPACITOR	CAP,MICA,150PF,+-5%,500V	1
Q001	329698	012	NPN 2N2484	TRANSISTOR,SI,NPN,SMALL SIGNAL	1
R001	268581	008	RESISTOR,VAR	RES,VAR,CERM,100K,+-20%,0.5W	1
R002	290122	007	RESISTOR	RES,MF,200.08K,+-0.1%,0.125W,50PPM	1
TP001	233411	020	PIN	PIN,SINGLE,PWB,0.058 DIA	1
TP002	233411	020	PIN	PIN,SINGLE,PWB,0.058 DIA	1

JFPN: 648642
NOUN: A21-44-4003
DESC: DISPLAY ASSY
Rev: -

REFDES	JFPN	ITM	Noun	Description	QPA
MP	648584	001	A21-44-3003	PCB DISPLAY	1
C001	519157	020	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C002	234484	021	CAPACITOR	CAP,POLYES,0.022UF,+-10%,250V	1
C101	519157	020	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C102	519157	020	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C103	519157	020	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C104	175224	023	CAPACITOR	CAP,MICA,12PF,+-5%,500V	1
C105	407361	022	CAPACITOR	CAP,CER,0.01UF,+-20%,100V,X7R	1
C201	446781	025	CAPACITOR	CAP,POLYPR,0.1UF,+-10%,160V	1
C202	436113	026	CAPACITOR	CAP,POLYES,0.22UF,+-10%,100V	1
C203	148429	027	CAPACITOR	CAP,MICA,470PF,+-5%,500V	1
C204	446773	024	CAPACITOR	CAP,POLYPR,0.047UF,+-10%,160V	1
C205	105692	028	CAPACITOR	CAP,CER,500PF,+-10%,1000V,X5R	1
C206	446773	024	CAPACITOR	CAP,POLYPR,0.047UF,+-10%,160V	1
C301	175224	023	CAPACITOR	CAP,MICA,12PF,+-5%,500V	1
C302	519157	020	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C303	519157	020	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
CR101	203323	032	DIODE 1N4448	DIODE,SI,BV=75V,IO=150MA,500MW	1
H001	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
H002	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
H003	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
H004	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
H005	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
H006	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
H007	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
H008	494641	054	SCREW	SCREW,PH,P,THD FORM,STL,5-20,.312	1
LCD001	723197	002	LCD	LCD,5 DIGIT,DIRECT DRIVE	1
LCD002	723197	002	LCD	LCD,5 DIGIT,DIRECT DRIVE	1
LCD003	723197	002	LCD	LCD,5 DIGIT,DIRECT DRIVE	1
LCD004	723197	002	LCD	LCD,5 DIGIT,DIRECT DRIVE	1
MP001	471730	003	8010A-2008	BRACKET,LCD	1
MP002	471730	003	8010A-2008	BRACKET,LCD	1
MP003	471730	003	8010A-2008	BRACKET,LCD	1
MP004	471730	003	8010A-2008	BRACKET,LCD	1
MP005	479642	004	8010A-2009	BEZEL, LCD	1
MP006	479642	004	8010A-2009	BEZEL, LCD	1
MP007	479642	004	8010A-2009	BEZEL, LCD	1
MP008	479642	004	8010A-2009	BEZEL, LCD	1
Q201	218396	035	NPN 2N3904	TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92	1
R001	441485	011	RESISTOR	RES,CF,200K,+-5%,0.25W	1
R002	348920	012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R003	441485	011	RESISTOR	RES,CF,200K,+-5%,0.25W	1
R004	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R005	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R006	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R101	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R102	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R103	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R104	348987	013	RESISTOR	RES,CF,1M,+-5%,0.25W	1
R105	343426	016	RESISTOR	RES,CF,1K,+-5%,0.25W	1
R201	348953	014	RESISTOR	RES,CF,220K,+-5%,0.25W	1
R202	109793	015	RESISTOR	RES,CC,1M,+-10%,1W	1
R203	348920	012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R204	348920	012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R205	348920	012	RESISTOR	RES,CF,100K,+-5%,0.25W	1
R301	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
R302	348839	010	RESISTOR	RES,CF,10K,+-5%,0.25W	1
U001	643114	037	CMOS 4332	IC,CMOS,32 BIT STAT SHFT REG/LCD DRVR	1
U002	404681	038	CMOS 4069UB	IC,CMOS,HEX INVERTER	1
U101	643106	040	CMOS 7224	IC,CMOS,4.5 DIGIT CNTR/DCDR/LCD DRIVR	1
U102	340117	041	CMOS 4013B	IC,CMOS,DUAL D F/F,+EDG TRIG	1
U103	536441	042	LSTTL 74LS160	IC,LSTTL,SYNC PRSET DECADE COUNTER	1

JFPN: 648642
NOUN: A21-44-4003
DESC: DISPLAY ASSY
Rev: -

REFDES	JFPN	ITM	Noun		Description	QPA
U104	507376	043	CMOS 4056B		IC,CMOS,BCD-7SEGMENT LCD DRIVER	1
U105	355172	044	CMOS 4001B		IC,CMOS,QUAD 2 INPUT NOR GATE	1
U201	429100	045	CMOS 8020	LIFE	IC,CMOS,3.5 DIGIT ADC,CUSTOM	1
U202	355222	039	CMOS 4030B		IC,CMOS,QUAD XOR GATE	1
U301	643106	040	CMOS 7224		IC,CMOS,4.5 DIGIT CNTR/DCDR/LCD DRIVR	1
U302	340117	041	CMOS 4013B		IC,CMOS,DUAL D F/F,+EDG TRIG	1
U303	355222	039	CMOS 4030B		IC,CMOS,QUAD XOR GATE	1
XLC001	453092	051	CONNECTOR		CONN,ELASTOMERIC,LCD TO PWB,2.000 L	1
XLC002	453092	051	CONNECTOR		CONN,ELASTOMERIC,LCD TO PWB,2.000 L	1
XLC003	453092	051	CONNECTOR		CONN,ELASTOMERIC,LCD TO PWB,2.000 L	1
XLC004	453092	051	CONNECTOR		CONN,ELASTOMERIC,LCD TO PWB,2.000 L	1
XU001	429282	050	SOCKET		SOCKET,IC,40 PIN	1
XU101	429282	050	SOCKET		SOCKET,IC,40 PIN	1
XU202	429282	050	SOCKET		SOCKET,IC,40 PIN	1
XU301	429282	050	SOCKET		SOCKET,IC,40 PIN	1
XY201	285346	048	SPACER		SPACER,SWITCH STANDOFF,POLY-E,.063	1
Y201	650390	047	CRYSTAL		CRYSTAL,3.84MHZ,+-0.05%,HC-18/U	1

JFPN: 718619
NOUN: A21-50-4004
DESC: SWITCH DECK 1, ASSY
Rev: -

REFDES	JFPN	ITM	Noun	Description	QPA
MP	718585	001	A21-50-3004	PCB SWITCH DECK 1	1
MP	729467	002	A21-50-8001	FREQUENCY SIGNAL SELECT SWITCH	1
MP	729483	003	A21-50-8002	RELAY TIMER SWITCH	1
MP	473322	004	8010A-8006	SWITCH ASSEMBLY,PUSHBUTTON	1
C110	519157	009	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
C153	519157	009	CAPACITOR	CAP,CER,0.22UF,+-20%,50V,Z5U	1
P012	352450	010	CONNECTOR	CONN,COAX,SMB(M),PWB	1
P014	352450	010	CONNECTOR	CONN,COAX,SMB(M),PWB	1
P015	352450	010	CONNECTOR	CONN,COAX,SMB(M),PWB	1
P018	352450	010	CONNECTOR	CONN,COAX,SMB(M),PWB	1
P027	631184	011	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P028	631184	011	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
P030	631184	011	HEADER	HEADER,1 ROW,.100CTR,4 PIN	1
R112	188417	006	RESISTOR	RES,CC,3.9M,+-5%,0.25W	1
R192	188417	006	RESISTOR	RES,CC,3.9M,+-5%,0.25W	1
R203	474445	008	RESISTOR	RES,MF,1K,+-0.1%,0.125W,50PPM	1
S001	520437	007	SWITCH	SWITCH,PUSHBUTTON,DPDT PUSH-PUSH	1
S002	520437	007	SWITCH	SWITCH,PUSHBUTTON,DPDT PUSH-PUSH	1
S003	520437	007	SWITCH	SWITCH,PUSHBUTTON,DPDT PUSH-PUSH	1
S010	520437	007	SWITCH	SWITCH,PUSHBUTTON,DPDT PUSH-PUSH	1

JFPN: 718627
NOUN: A21-50-4005
DESC: SWITCH DECK 2, ASSY
Rev: -

REFDES	JFPN	ITM	Noun	Description	QPA
MP	718593	001	A21-50-3005	PCB SWITCH DECK 2	1
MP	729475	002	A21-50-8004	MULTIMETER INPUT SELECT SWITCH	1

JFPN: 648675
NOUN: A21-44-4006
DESC: SW. DECK 3 ASSY
Rev: -

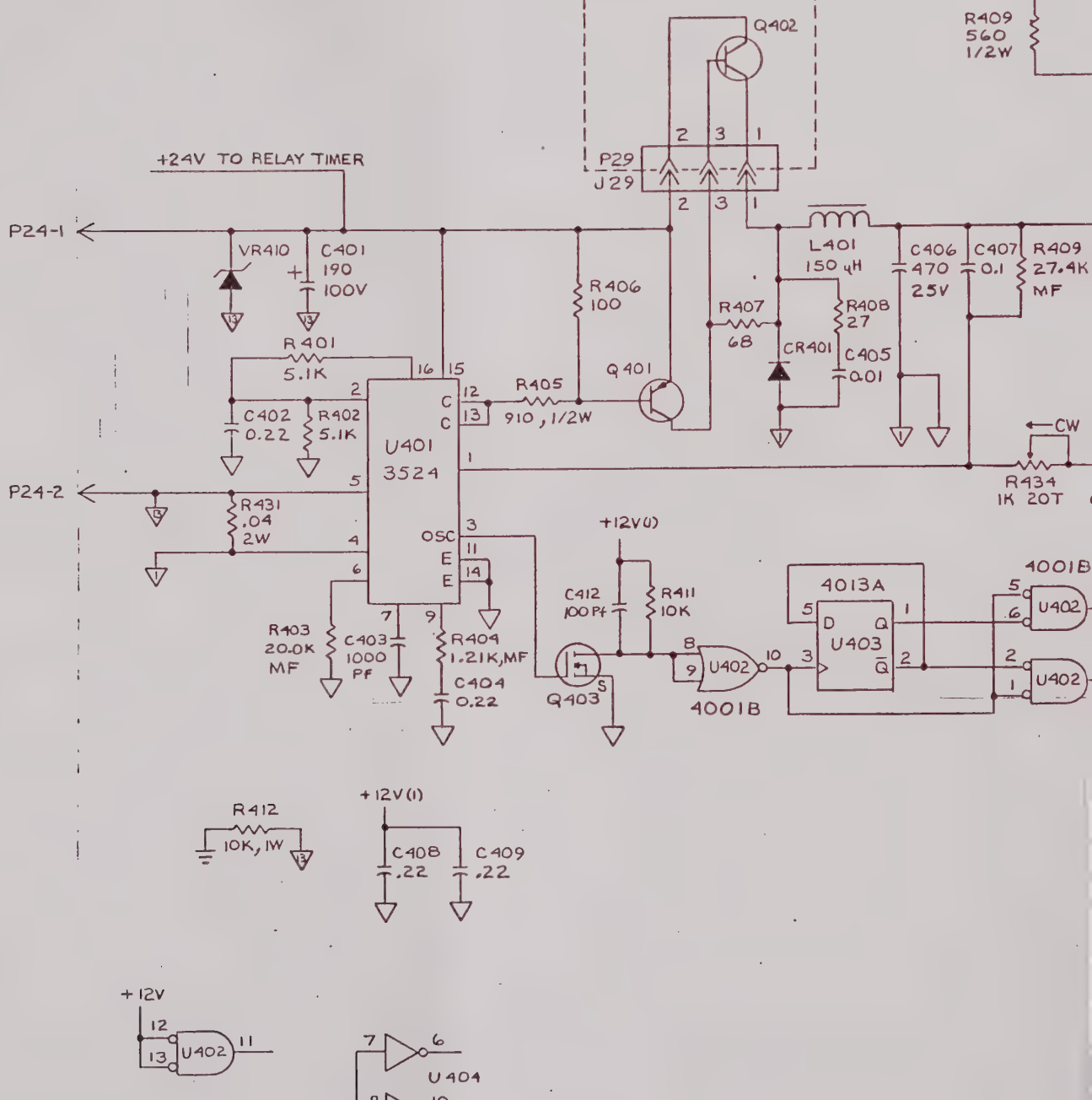
REFDES	JFPN	ITM	Noun	Description	QPA
H	631317	010	HEAT DISSIPATOR	HEAT DIS,HORIZ,1.55X1.04X.75,TO-66	1
H	110635	011	NUT	NUT,HEX,STL,4-40	2
H	110403	012	WASHER	WASHER,LOCK,INTRNL,STL,.123ID	2
H	603894	014	STUD	STUD,BROACH,PH BRNZ,4-40,.375	2
H	854088	015	LABEL	LABEL,ADHES,MYLAR,.900,.200	1
MP	648618	001	A21-44-3006	PCB SW. DECK 3	1
MP	634352	003	A21-44-8005	RANGE SELECT SWITCH	1
R282	151324	005	RESISTOR	RES,MF,1K,+-1%,0.5W,100PPM	1
R283	151043	006	RESISTOR	RES,MF,10,+-1%,0.5W,100PPM	1
Q256	385302	008	NPN POWER, 2N4240	TRANSISTOR,SI,BVCBO=500V,20W,TO-66	1

JFPN: 734889
NOUN: A21-50-4008
DESC: T/C SELECT ASSY
Rev: -

REFDES	JFPN	ITM	Noun	Description	QPA
MP	734897	001	A21-50-3008	PCB, T/C SELECT	1
MP	634337	002	A21-44-8003	T/C SELECT SWITCH	1
TP	512889	004	TERMINAL	TERM,FASTON,TAB,.110,SOLDER	1

JFPN: 718635
NOUN: A21-50-4009
DESC: MULTIMETER INPUT ASSY
Rev: -

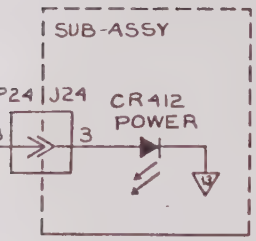
REFDES	JFPN	ITM	Noun	Description	QPA
F	475004	007	FUSE	FUSE,.406,1.375,3A,600V,FAST	1
H	103424	008	RIVET	RIVET,S-TUB,OVAL,STL,.118,.156	2
MP	718601	001	A21-50-3009	MULTIMETER INPUT PCB	1
MP	103028	009	HOLDER	HLDR,COMPONENT,13/32,PWB MT	2
R	109397	005	RESISTOR	RES,CC,100K,+-10%,1W	1
R	474080	006	RESISTOR	RES,MF,1K,+-1%,100PPM,FLMPRF,FUSIBLE	1



CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
—	RELEASE TO PRODUCTION		SCB 7/14/84	[illegible] 8/1/84		[illegible] 7/31/84

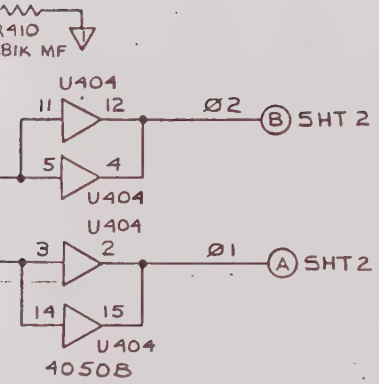
A21-50-1001 SH 1 OF 9 REV —



+12V(1)

NOTES: UNLESS OTHERWISE SPECIFIED

1. SEE A21-50-1601 FOR REFERENCE DESIGNATOR DRAWING.
2. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 & Y32.14.
3. ALL RESISTORS ARE 1/4W, 5%, CARBON FILM. ALL RESISTANCE IS IN OHMS.
4. ALL CAPACITANCE IS IN MICRO-FARADS.
5. REFERENCE DESIGNATOR CHARTS FOR POWER SUPPLY CONNECTIONS ARE IN RESPECTIVE SECTIONS.
6. SEE A21-50-4001 FOR ASSEMBLY DRAWING.



REFERENCE DESIGNATION		
FIRST USED	LAST USED	NOT USED
U401	U404	
R401	R434	R428, R429
Q401	Q419	Q404, Q407
CR410	CR412	CR411
VR402	VR410	
C401	C418	C409, C418
L401	L401	
T1	T4	
S401	S404	

REFERENCE DESIGNATION FOR SWITCHES & CONNECTORS		
FIRST USED	LAST USED	NOT USED
S1	S46	S21, S28
P2	P29	P16
J2	J29	J16

REF DES	+12V (1)	▽
U401	--	4,5,8,10,11,14
U402	12,13,14	7
U403	9,11,14	4,6,7,8,10
U404	1,16	7,8,9

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

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XX = ±
.XXX = ±
ANGLES = °
DIMENSIONS IN INCHES
X_C =
FINISH

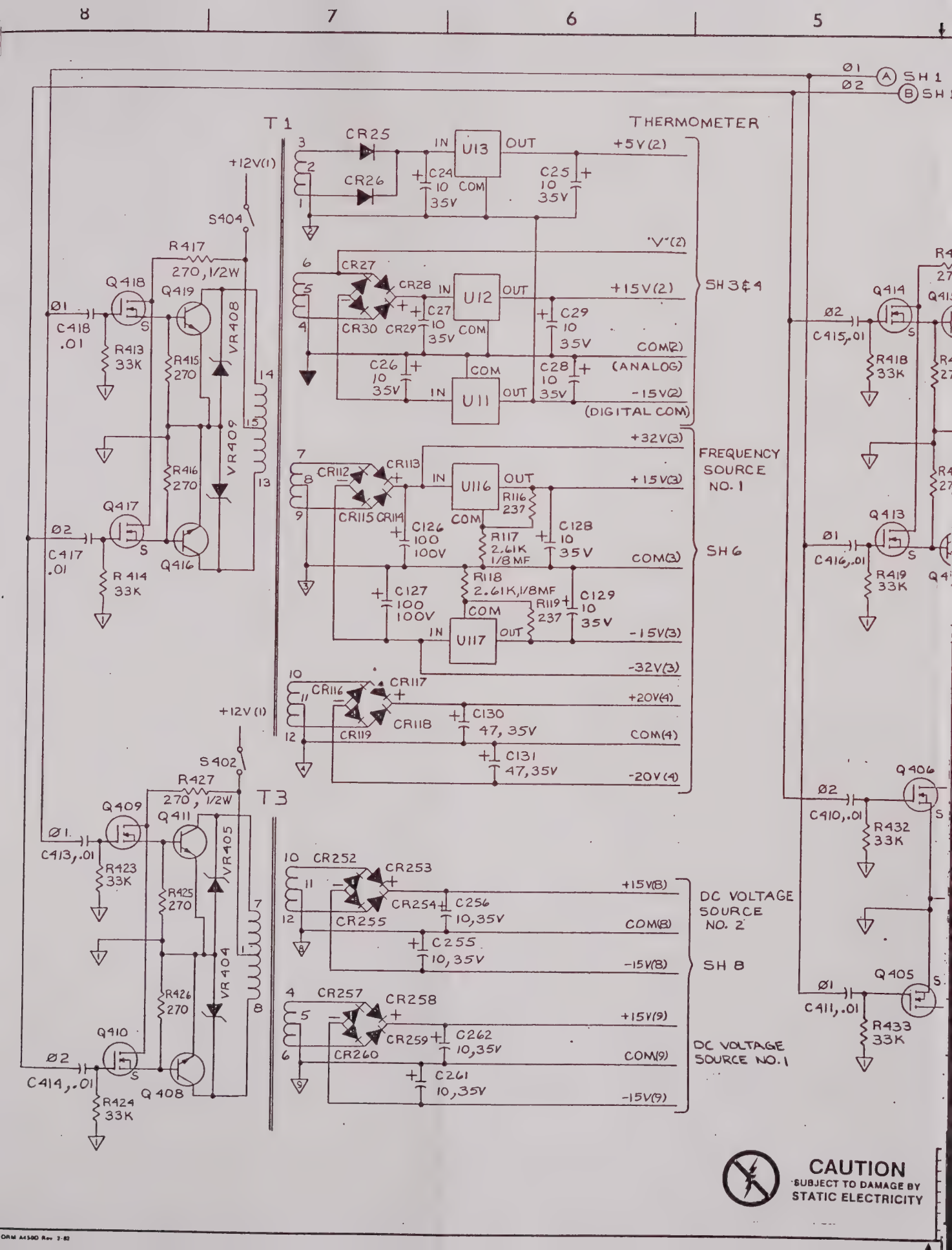
DWN	B. HANSON	4-9-84
CHK	[illegible]	8/8/84
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A. K. LOFTIS	7/31/84

SCHEMATIC, MAIN PCB ASSEMBLY (PREREGULATOR)

PART NO.	SIZE	DRAWING NO
	D	A21-50-1001
SCALE	SH 1 OF 9	REV —

BASIC DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

PROPRIETARY


8
7
6
5
T1
T3
THERMOMETER
CR25
CR26
U13
IN
OUT
C24
10
35V
COM
C25
10
35V
+5V(2)
"V"(2)
CR27
CR28
CR29
CR30
U12
C27
C29
+15V(2)
COM(2)
(ANALOG)
C26
C28
U11
-15V(2)
(DIGITAL COM)
SH 3&4
+32V(3)
CR112
CR113
CR114
CR115
U116
R116
237
+15V(3)
C126
100
100V
R117
2.61K
1/8MF
C128
COM(3)
R118
2.61K,1/8MF
C127
R119
C129
U117
-15V(3)
-32V(3)
FREQUENCY
SOURCE
NO. 1
SH 6
CR116
CR117
CR118
CR119
+20V(4)
C130
47, 35V
COM(4)
C131
-20V(4)
CR252
CR253
CR254
CR255
C256
10,35V
C255
+15V(8)
COM(8)
-15V(8)
SH 8
DC VOLTAGE
SOURCE
NO. 2
CR257
CR258
CR259
CR260
C262
C261
+15V(9)
COM(9)
-15V(9)
DC VOLTAGE
SOURCE NO. 1
+12V(1)
S404
S402
R417
270,1/2W
R427
Q418
Q419
Q417
Q416
Q409
Q411
Q410
Q408
Q414
Q413
Q406
Q405
VR408
VR409
VR405
VR404
Ø1
Ø2
C418
.01
C417
C413,.01
C414,.01
C415,.01
C416,.01
C410,.01
C411,.01
R413
33K
R414
R415
270
R416
R423
R424
R425
R426
R418
R419
R432
R433
A
B
SH 1
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHEET ONE					

A21-50-1001 REV — SH 2 OF 9

T2

+12V(1) S403 T2 5 6 CR104 CR105 CR107 CR106 U107 IN OUT COM C111 10 35V C112 10 35V +5V(5) COM(5) COUNTER SHT5

+32V(6) 10 11 12 CR124 CR125 CR126 CR127 U118 IN OUT COM R197 237 C145 10 35V R196 2.61K 1/8W MF C143 100 100V +15V(6) COM(6) FREQUENCY SOURCE NO.2

C144 100 100V R195 2.61K 1/8W, MF C146 10 35V R194 237 U119 IN OUT -15V(6) -32V(6) SHT6

7 8 9 CR128 CR129 CR130 CR131 C147 47 35V C148 47 35V +20V(7) COM(7) -20V(7)

VR407 VR406 VR402 VR403

T4

+12V(1) S401

4 5 6 CR262 CR263 C266 10 35V +8V(10) COM(10)

3 2 1 CR264 CR265 C267 22 50V R235 5.6K 1/2W +32V(10) CURRENT SOURCE SHT8

12 11 10 CR209 CR210 C230 47,35V C231 47,35V +15V(11) COM(11) -15V(11)

CR211 C232 47 35V R240 1.0K +10V(12) -12V(12) (COM) MULTIMETER SHT7

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

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DWN	B. HANSON	4-9-84
CHK		
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. WEISE	7/31/84

FINISH

SCHEMATIC, MAIN PCB ASSEMBLY (POWER SUPPLY)

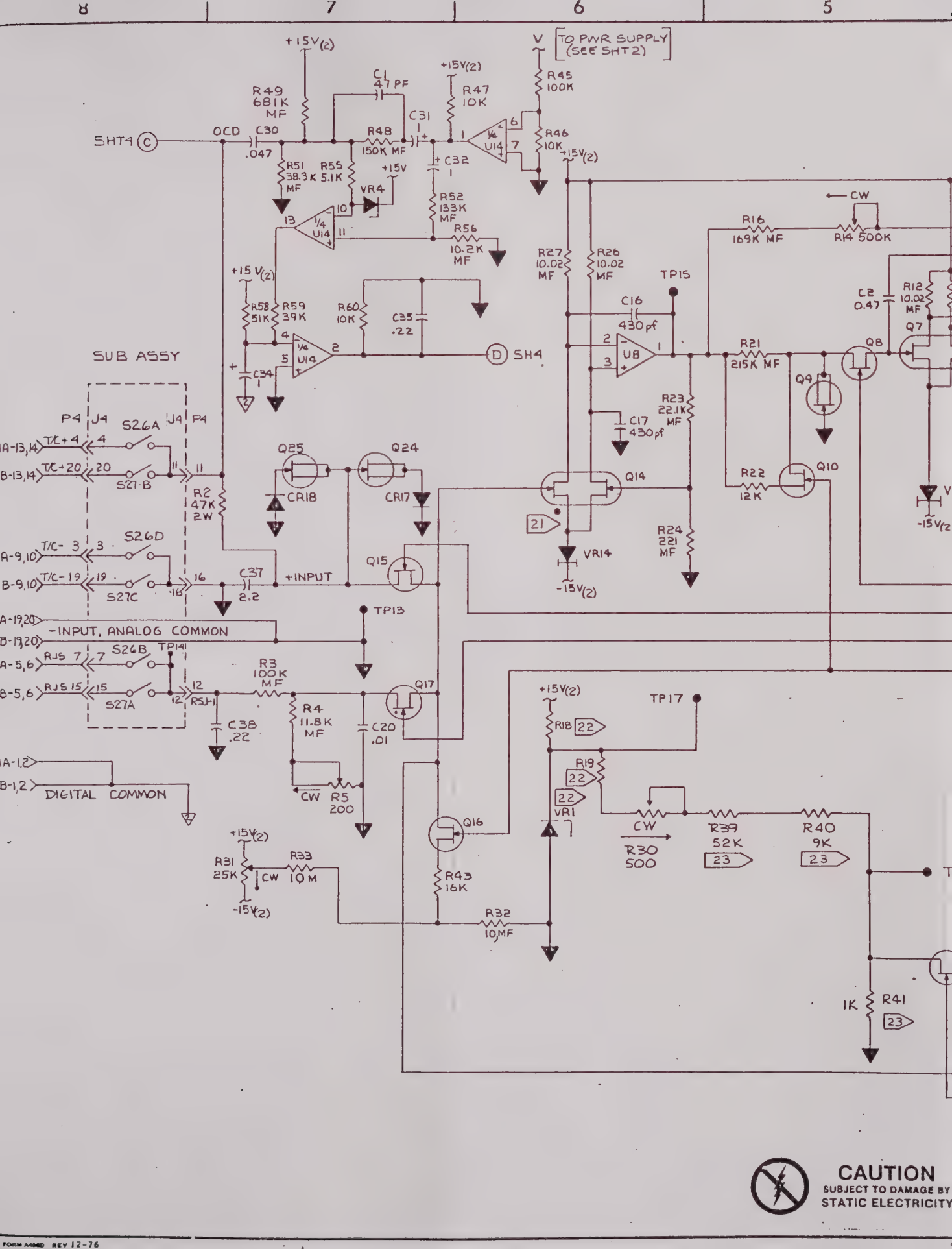
PART NO.	SIZE	DRAWING NO
	D	A21-50-1001

SCALE — SH 2 OF 9 REV —

BASIC DWG NO SUFFIX | DRAWING NO | PART NO. FIRST USED ON | APPLICATION

PROPRIETARY

DIST

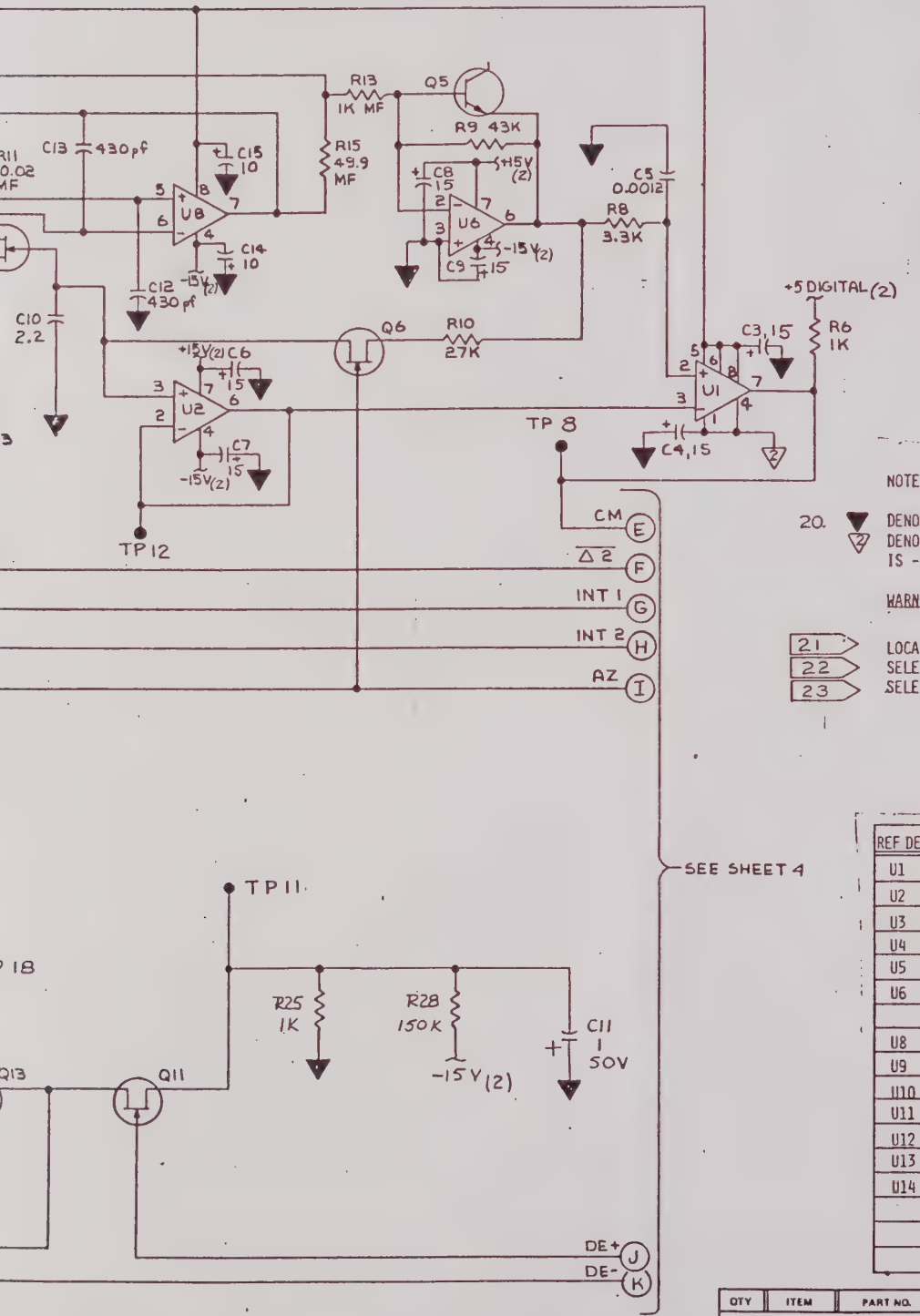


CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHT 1 FOR REVS



REF DES	LAST USED	NOT USED
U1	U21	U5, U7, U9, U10, U15 THRU U19
R2	R83	R7, R17, R20, R29, R34 THRU R38, R53, R54, R61 THRU R64, R72, R73, R74
Q5	Q25	Q12, Q18 THRU Q22
CR15	CR30	CR19, CR21 THRU CR24
VR1	VR75	VR2, VR3, VR5 THRU VR12, VR15 THRU VR18, VR20 THRU VR74
C1	C41	C18, C19, C21, C22, C33, C39
Z5	Z5	
TP1	TP19	TP13 TP15

REF DES CHART

NOTES: (CONT.)

20. ▼ DENOTES ANALOG COMMON (0 VOLTS), ▽ DENOTES DIGITAL COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON.

WARNING: DO NOT CONNECT ▽ TO ▼, DAMAGE MAY RESULT.

21 LOCATE WITH MARKED GATE IN POSITION SHOWN.
22 SELECTED SET.
23 SELECTED SET.

REF DES	+5 DIG (2)	+15V(2)	▽	▼
U1		5,6,8	1,4	
U2		7	4	
U3	14		7	
U4	40		20,21	
U5				1
U6		7	4	
U8		8	4	
U9				7,8
U10			4	5,6
U11				
U12				
U13				
U14		3	12	5,7

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

PARTS LIST

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DIMENSIONS IN INCHES X_C = —

DWN	L. Isaacson	12-16-80
CHK	MARK SMITH	2-14-81
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. WEISS	7/31/84
FINISH	—	

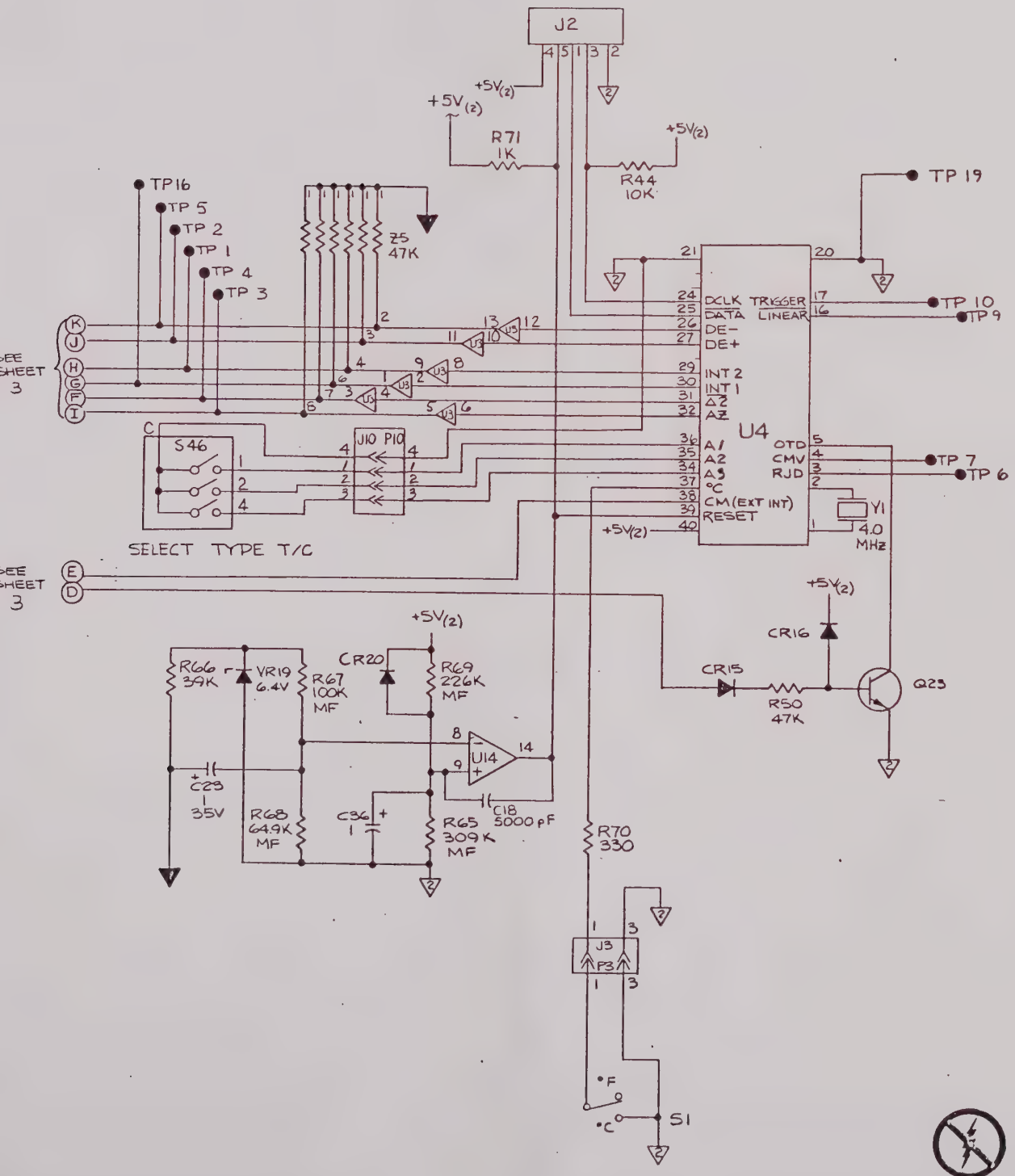
SCHEMATIC, MAIN PCB ASSEMBLY (THERMOMETER)

PART NO.	SIZE	DRAWING NO
—	D	A21-50-1001

SCALE — SH 3 OF 9 REV —

BASIC
DWG NO. SUFFIX | DRAWING NO | PART NO.
FIRST USED ON
APPLICATION

DIST



CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

REVISIONS

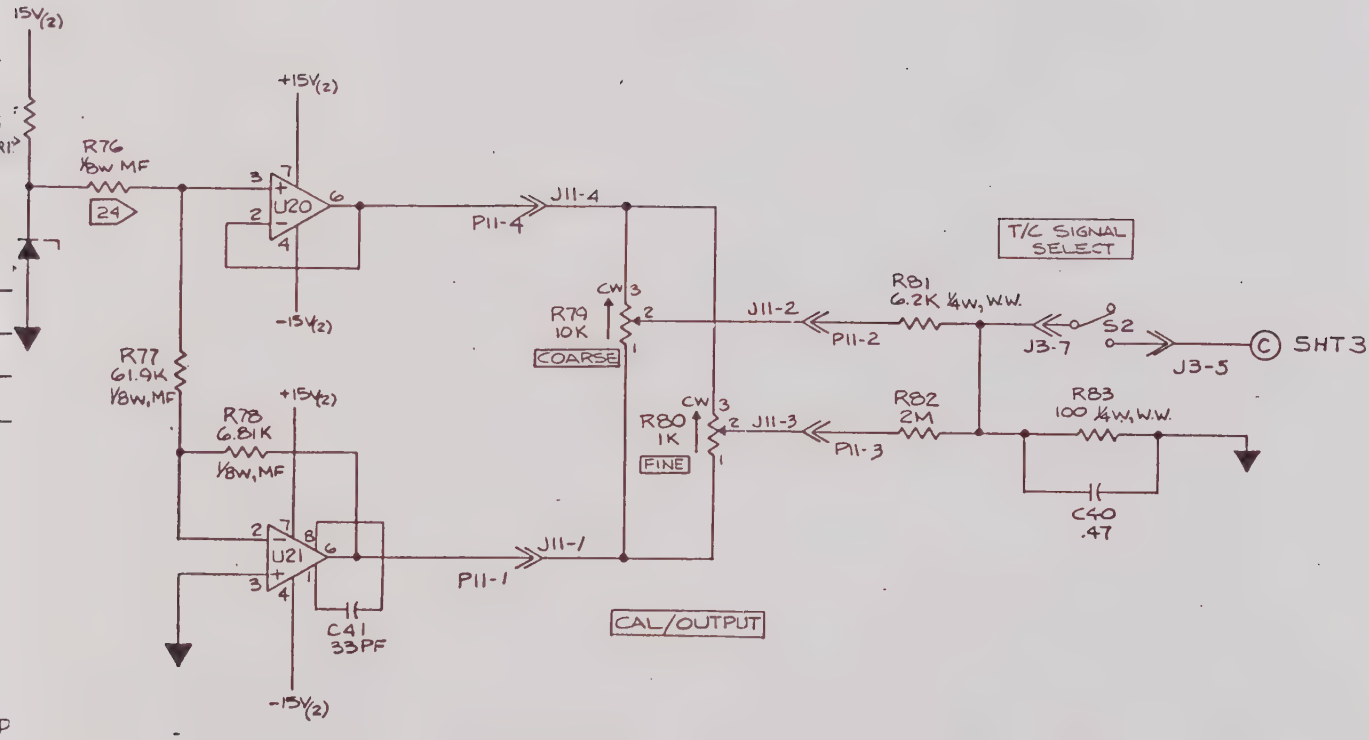
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHT 1 FOR REVS

A21-50-1001 REV | SH 4 OF 9

NOTES: (CONT.)

24 SELECTED SET



PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

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MOUNTLAKE TERRACE, WA 98043

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE
.XX = ± —
.XXX = ± —
ANGLES = ± —
DIMENSIONS IN INCHES
x_c = —

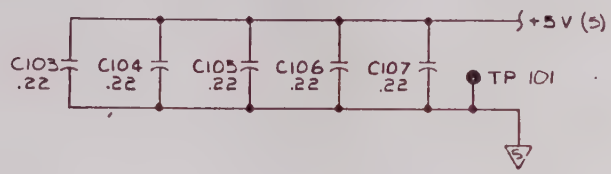
DWN	MARK SMITH	2-19-84
CHK	D.C. BARRETT	2/14/84
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. WEISS	7/31/84
FINISH	—	

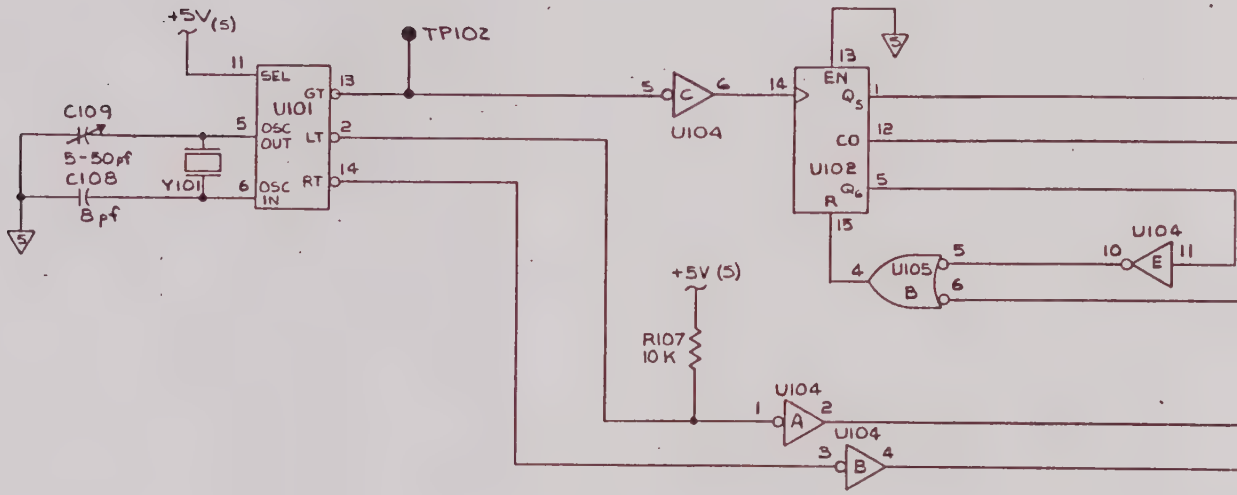
SCHEMATIC, MAIN PCB ASSEMBLY (THERMOMETER, CALIBRATOR)

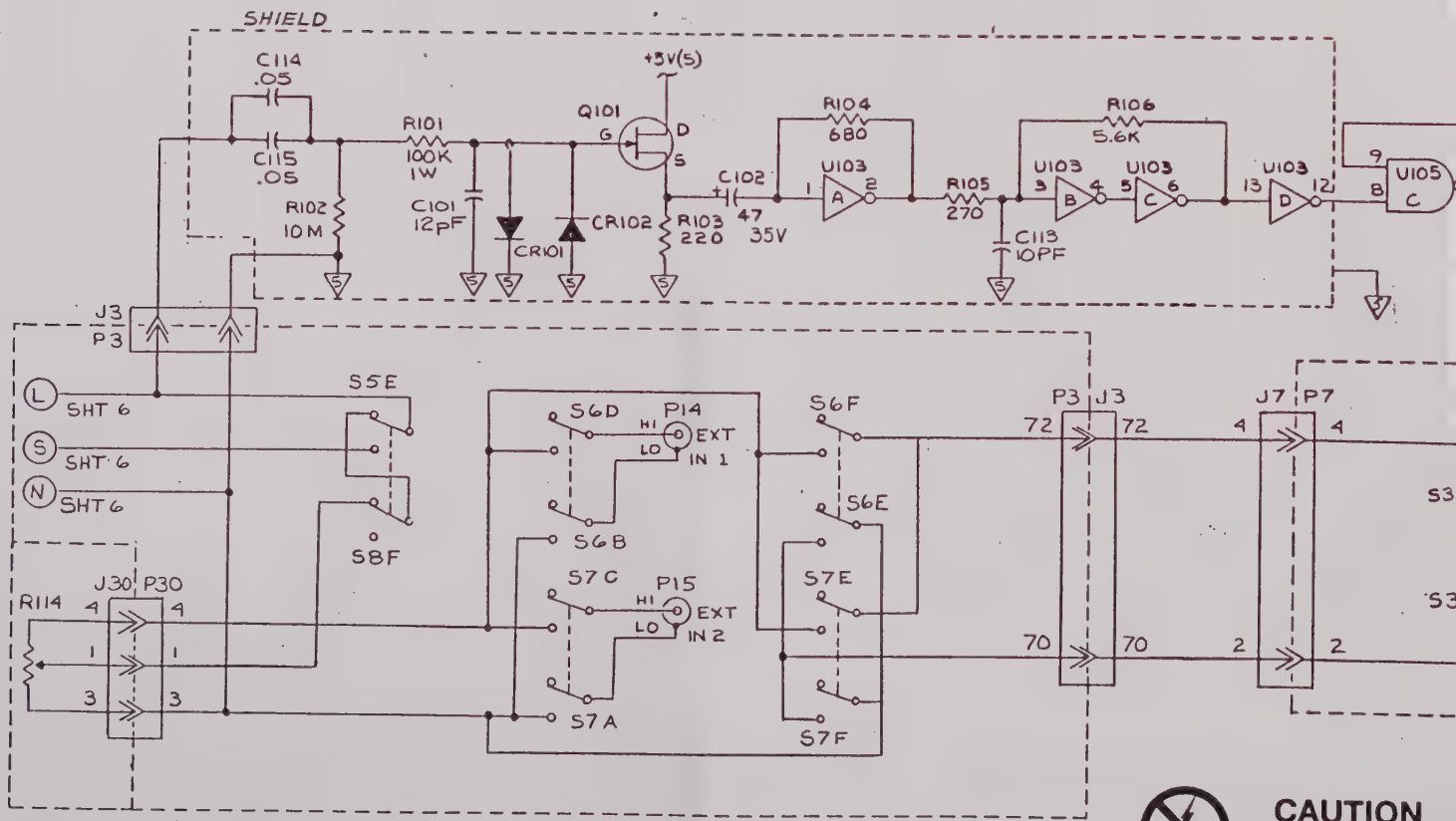
BASIC		
DWG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

PART NO.	SIZE	DRAWING NO
—	D	A21-50-1001
SCALE —	SH 4 OF 9	REV —

DIST







CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

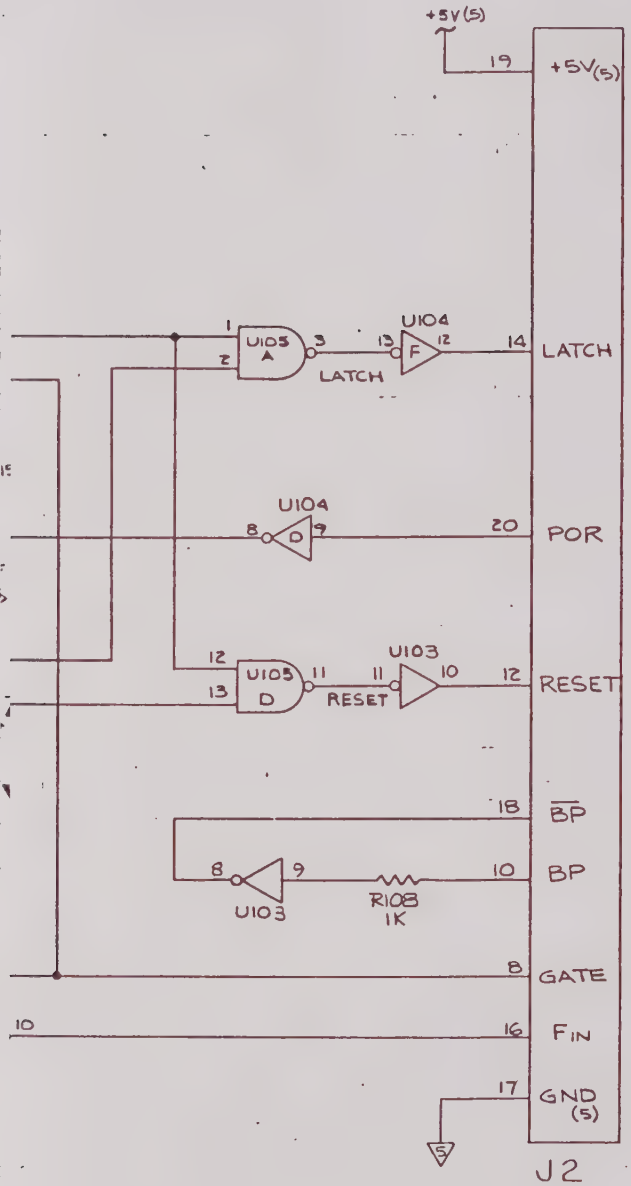
A21-50-1001 SH 5 OF 9 REV —

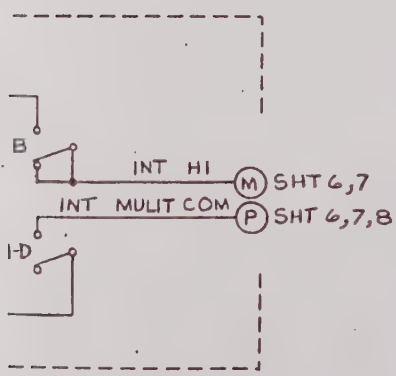
REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHT 1 FOR REVS					

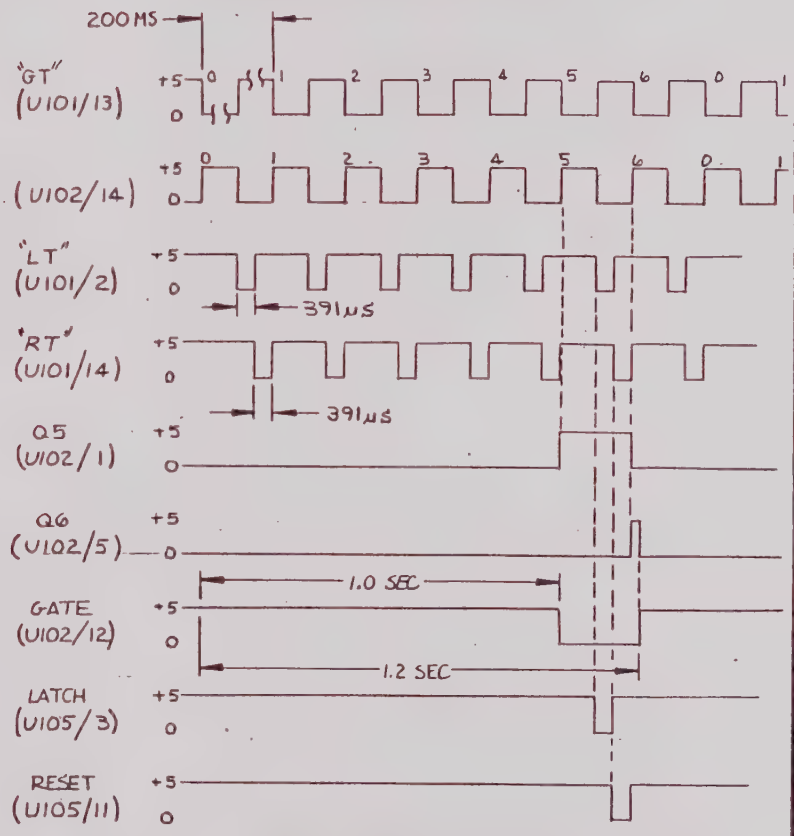
NOTES: UNLESS OTHERWISE SPECIFIED

(14) PIN NUMBERS SHOWN REFER TO CONNECTIONS BETWEEN A1-J4 AND A5-P4 (TYP).





COUNTER CONTROL TIMING



REF DES	+5V	GND
U101	10,11	4
U102	16	8,13
U103	14	7
U104	14	7
U105	14	7

REF DES CHART

FIRST USED	LAST USED	NOT USED
U101	U119	U106
R101	R197	R120, 121
Q101	Q109	
CR101	CR131	CR103
VR110	VR123	VR112 THRU VR121
C101	C154	C110
TP101	TP102	
L101	L102	

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

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89536

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TOLERANCE .XX = ± .XXX = ± ANGLES = ±
DIMENSIONS IN INCHES

DWN	L. Isaacson	11-10-82
CHK	D.C. BARRETT	5/14/82
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	J.K. WEISS	7/5/84

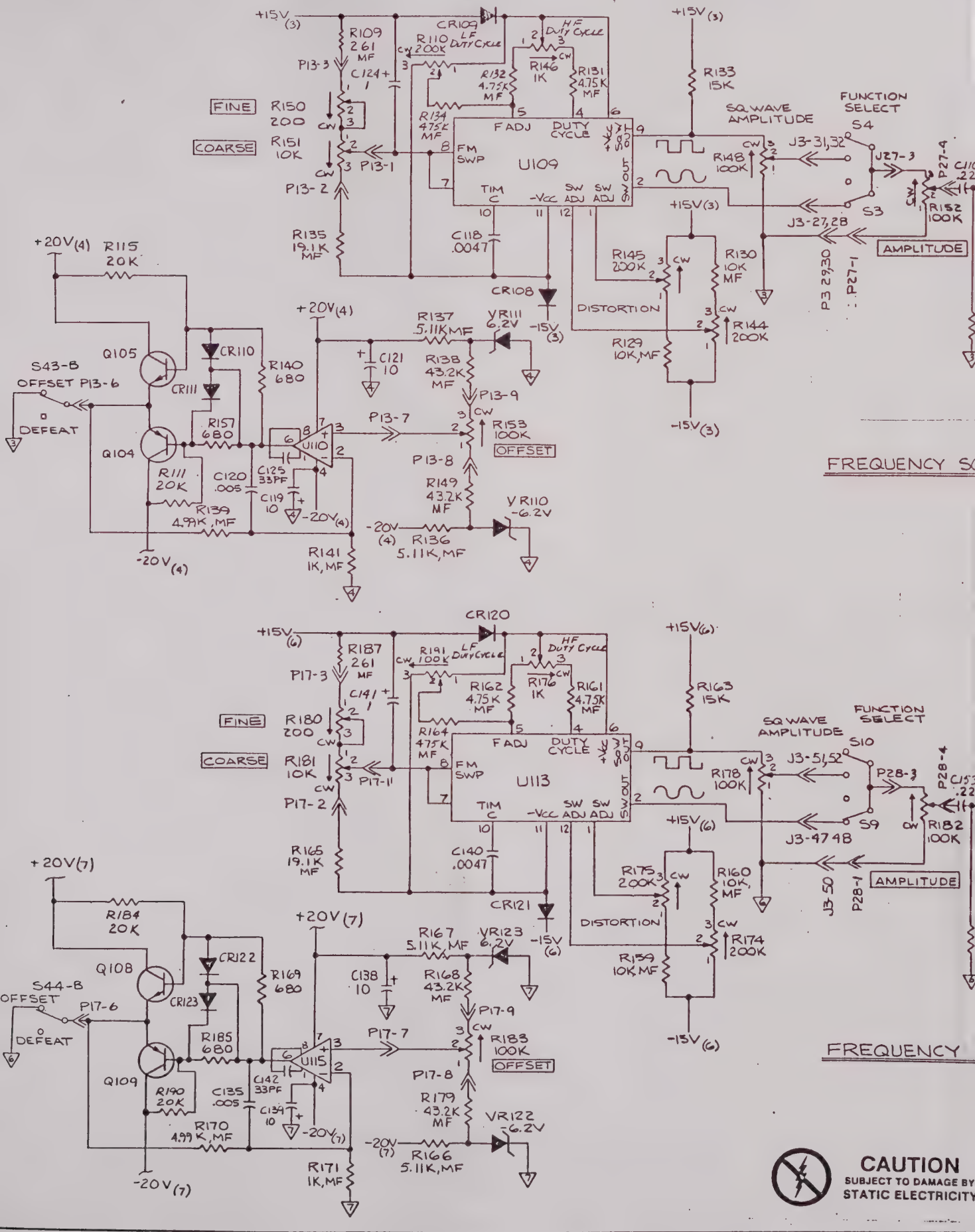
FINISH

SCHEMATIC, MAIN (AUDIO FREQUENCY)

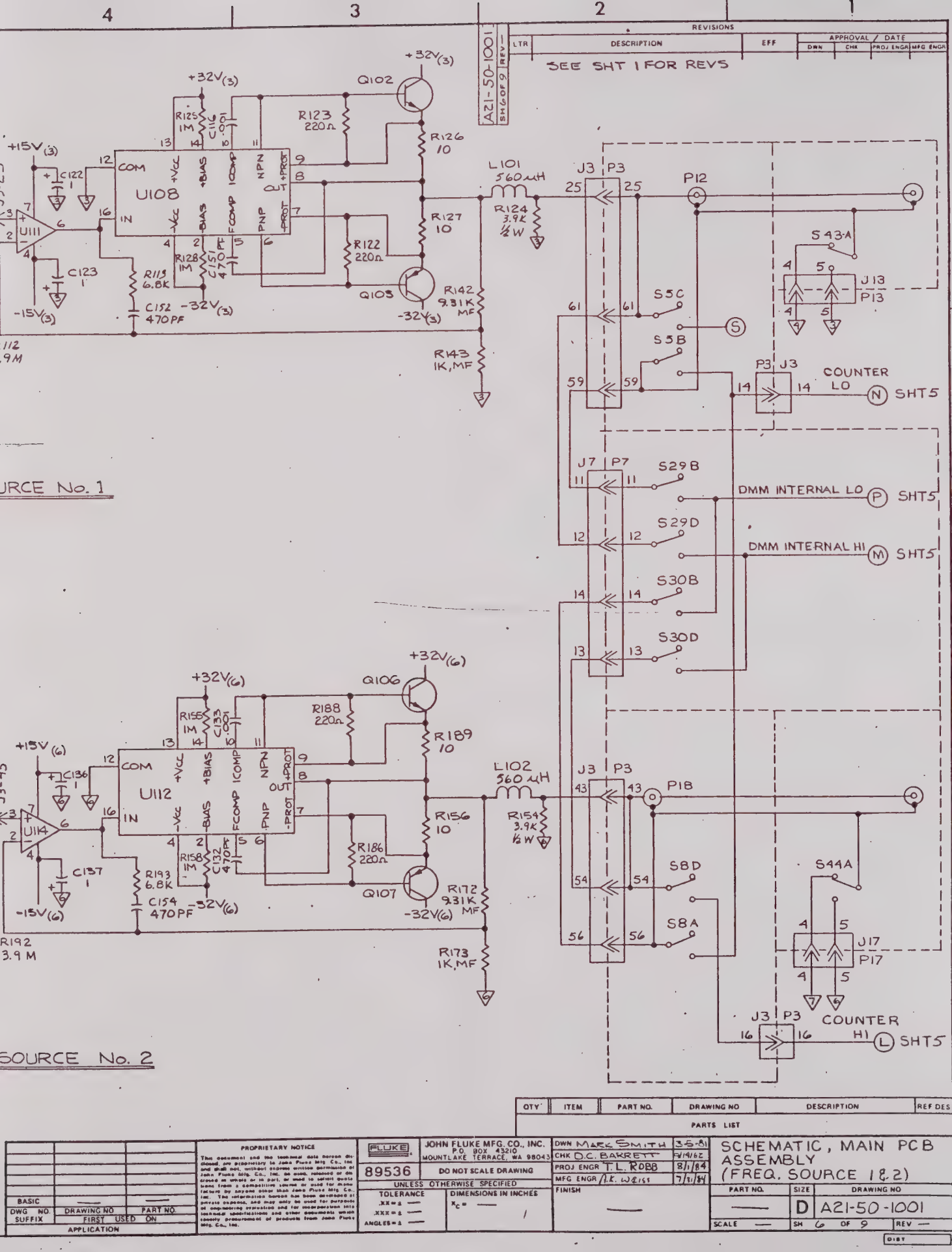
BASIC DWG NO. SUFFIX	DRAWING NO FIRST USED ON	PART NO.
APPLICATION		

PART NO.	SIZE	DRAWING NO
	D	A21-50-1001
SCALE —	SH 5 OF 9	REV —

DIST



CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY



QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

BASIC	—	—
DWG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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TOLERANCE
.XX = ±
.XXX = ±
ANGLES = ±

DIMENSIONS IN INCHES
X_C =

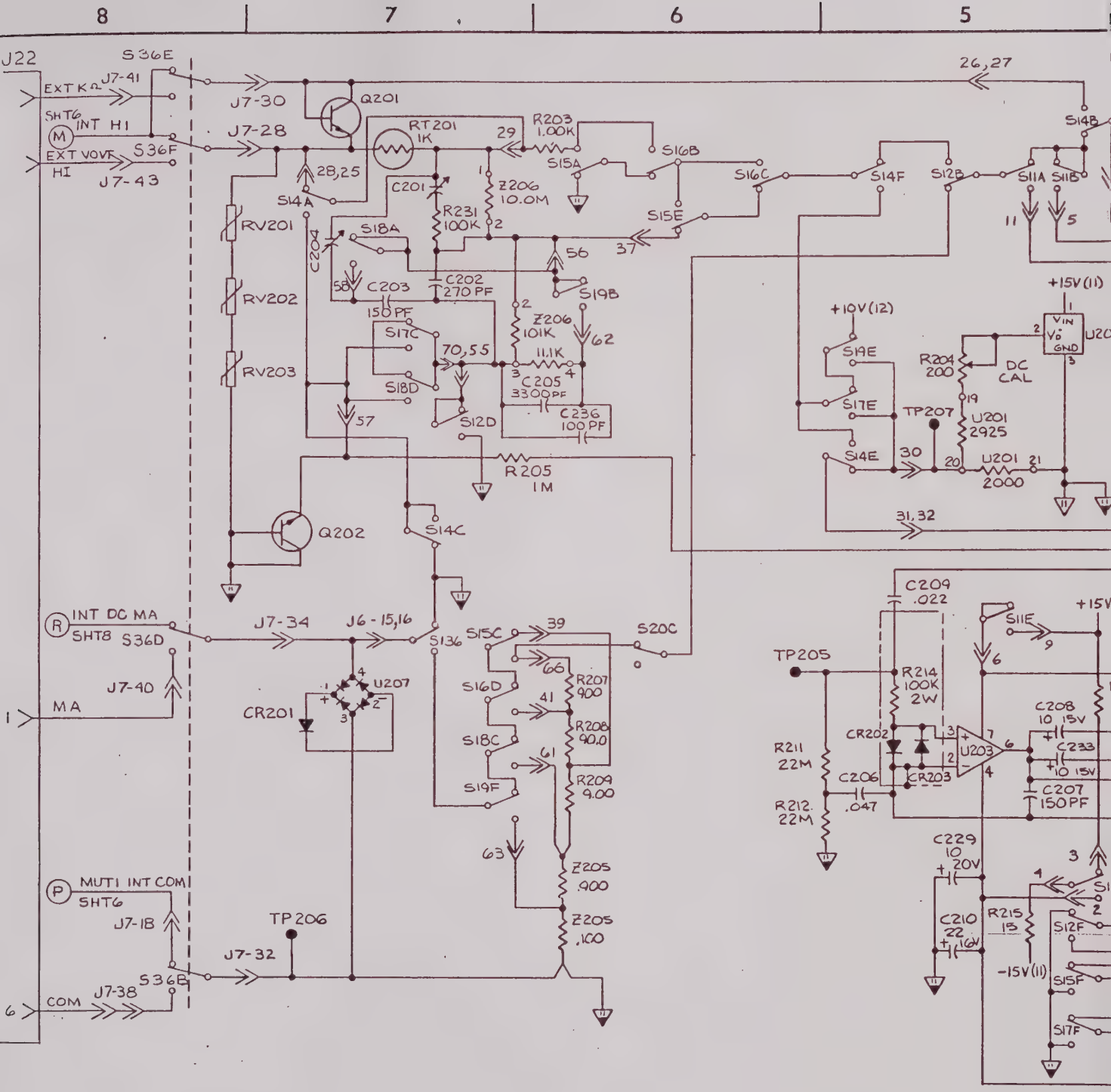
FINISH —

DWN	MARK SMITH	3-5-81
CHK	D.C. BARRETT	3/19/82
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	J.K. WEISS	7/31/84

SCHEMATIC, MAIN PCB ASSEMBLY (FREQ. SOURCE 1 & 2)

PART NO.	SIZE	DRAWING NO
—	D	A21-50-1001
SCALE —	SH 6 OF 9	REV —

DIST



CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHT 1 FOR REVS					

A21-50-1001 REV 1 SH 7 OF 9

16, 19, 20, 45, 46

23

TP201

NOTES: (CONT.)

40. NUMBERS ADJACENT TO ≫ INDICATE PIN NUMBERS ON J6/P6.

41. SWITCH IDENTIFICATION:

S11 = AC/DC	S17 = 20
S12 = VOLTS	S18 = 200
S13 = mA	S19 = 2K
S14 = KΩ	S20 = 20MΩ/10A
S15 = .2	S36 = MULTIMETER EXTERNAL
S16 = 2	INPUT

REF DES CHART

FIRST USED	LAST USED	NOT USED
U201	U256	U204 U205 U206 U208 THRU U250
R201	R292	R206, R210, R216, R217, R224 THRU R229, R232, R233, R234, R236 THRU R239, R241 THRU R247
Q201	Q256	Q203, Q204, Q206 THRU Q250
CR201	CR265	CR204 THRU CR208, CR212 THRU CR250
VR202	VR202	
C201	C269	C213, C214, C215, C217, C220 THRU C228, C235, C235, C237 THRU C247, C250
TP201	TP207	
Z204	Z206	
L250	L252	

J5 11 HI, 10 +REF, 7 -REF, 9 GND, 13 LO, 14 -12V (12)

C216 .01, R218 1K, TP203, R213 1, U201 RMS TO DC CONVERTER, TP202, U201 1.80K, U201 200, C218 2.2, R219 5K AC HI, R220 2.2M, R221 1M AC LO, C234 .01, C219 10 35V, VR202 4.3V, COM, -V

Q205, R222 470K, -15V(11), +10V(12), TST, RNG, DP4, DP3, DP2, +10V (12) J5

C211 .01, R223 1M, Z204 4.7K, Z204 20K, Z204 20K, Z204 20K, S18B, S20D, S17A, S17C, S14D, S13A, S15D, S11D, S17B, S13D, S12C, S16A, S17D, S20B, S19A, S20A, +VDD

71,72 67 18 21 17 36,35 54 53 64

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

PARTS LIST

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DIMENSIONS IN INCHES X_C =

FINISH

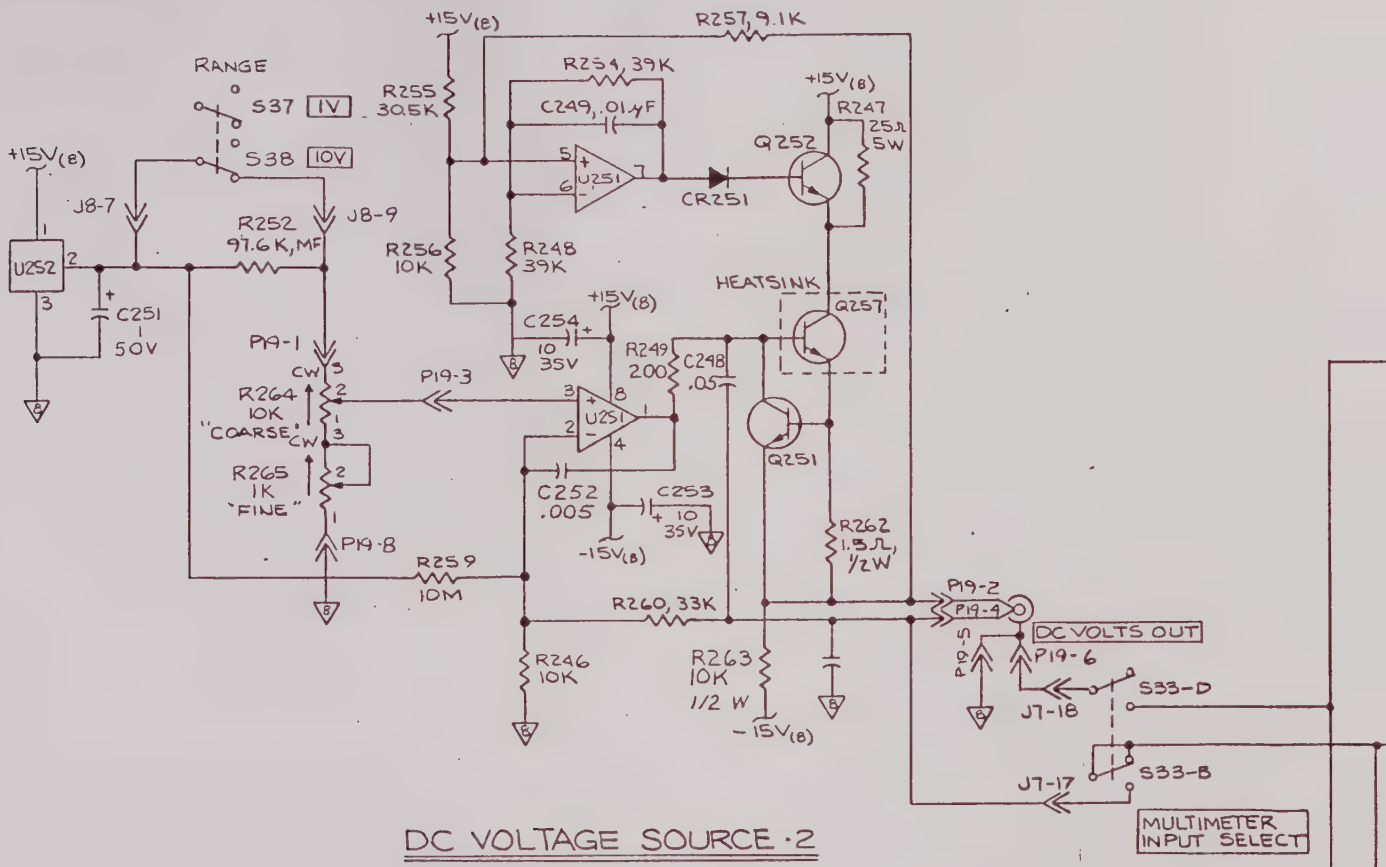
DWN	MARK SMITH	2-1-76
CHK	D.C. BARRETT	9/14/82
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. WISTI	7/31/84

SCHEMATIC, MAIN PCB ASSEMBLY (MULTIMETER)

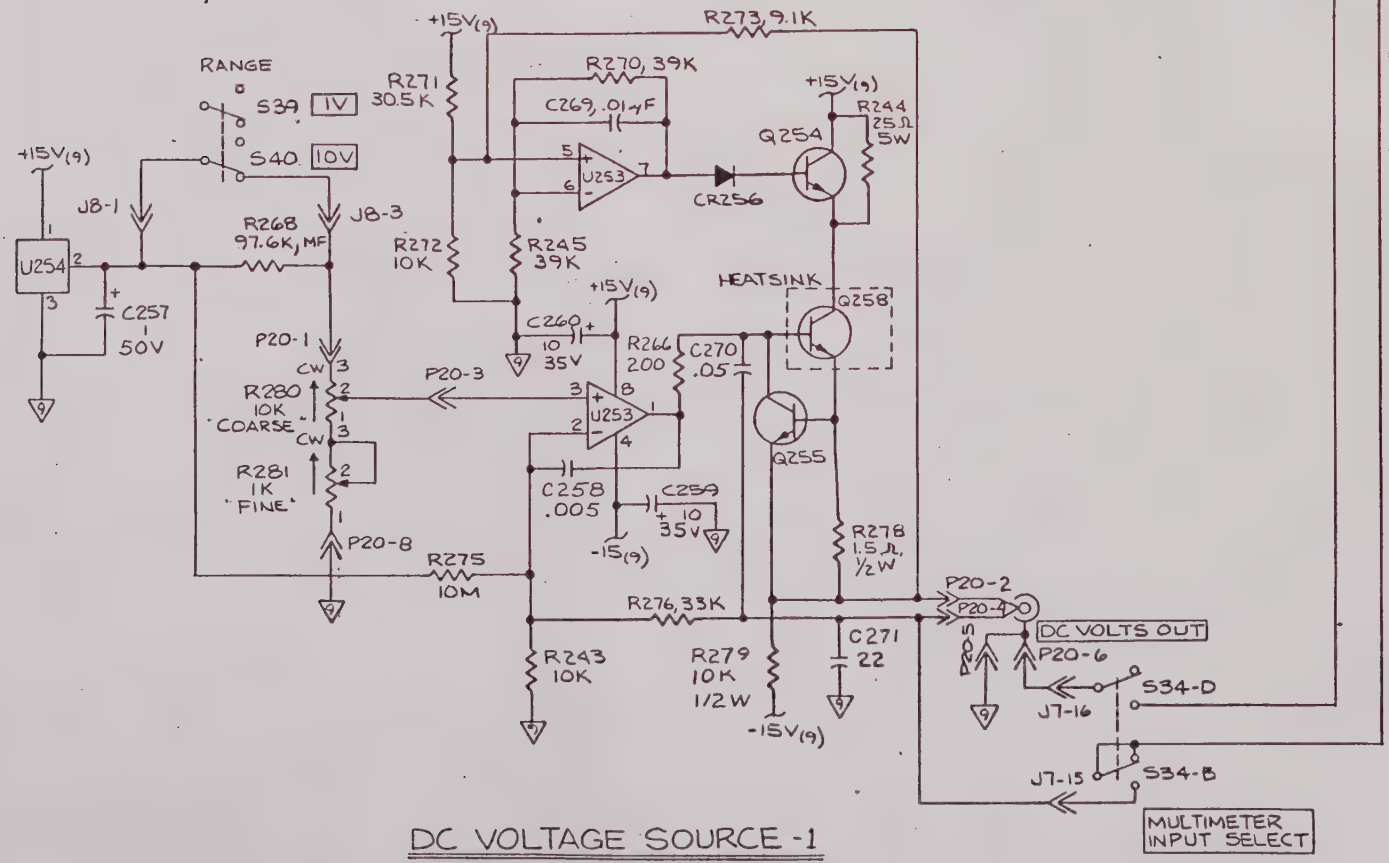
BASIC		
DWG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

PART NO.	SIZE	DRAWING NO.
	D	A21-50-1001
SCALE —	SH 7 OF 9	REV —

DIST



DC VOLTAGE SOURCE -2

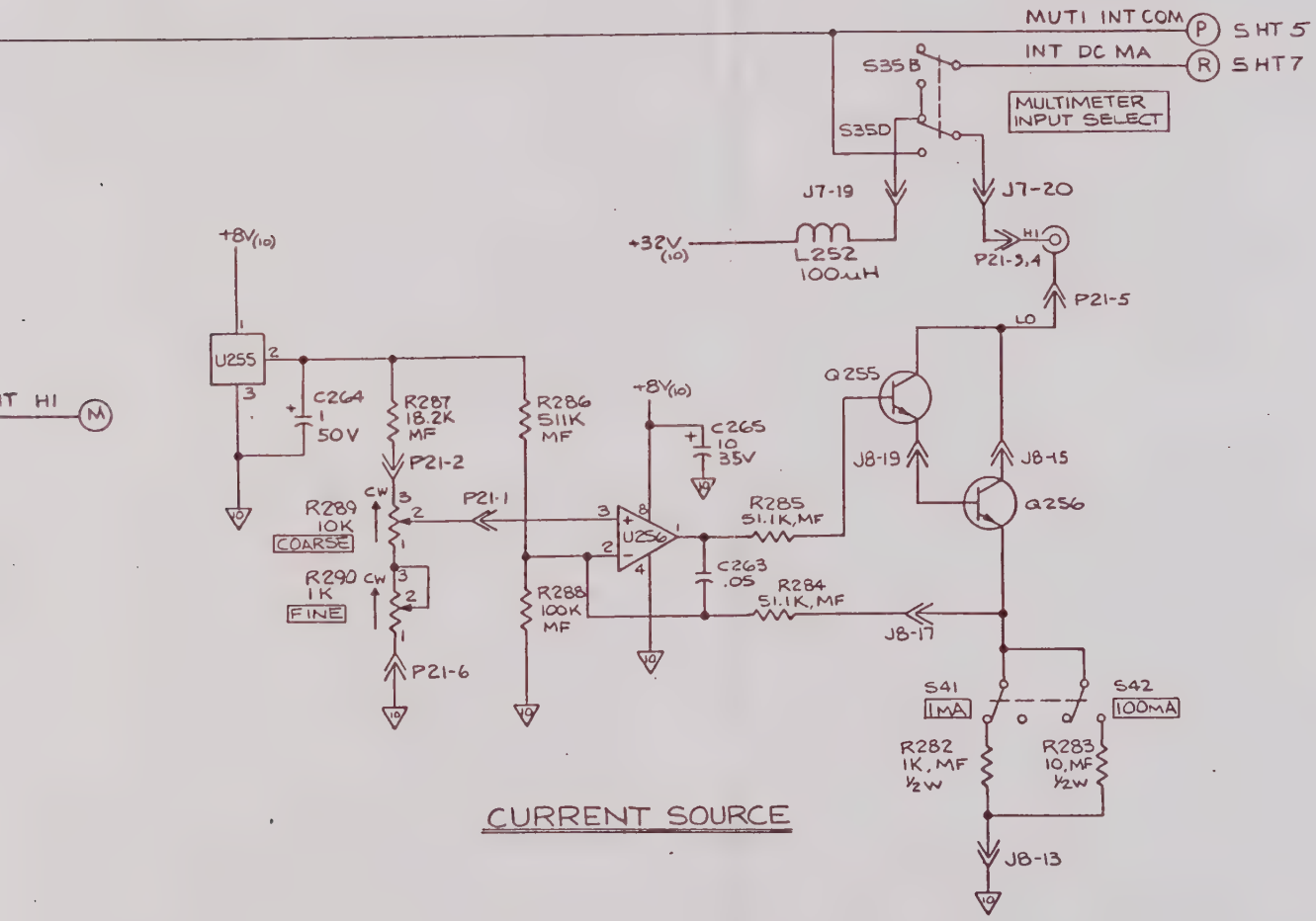


DC VOLTAGE SOURCE -1

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHT 1 FOR REVS					

A21-50-1001 SH 8 OF 9 REV —



CURRENT SOURCE

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

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TOLERANCE .XXX = ± ANGLES = ±
DIMENSIONS IN INCHES

DWN	Mark Smith	3-30
CHK	D.C. HARKETT	9/14/82
PROJ ENGR	T.L. ROBB	9/1/84
MFG ENGR	A.E. LEWIS	7/5/84

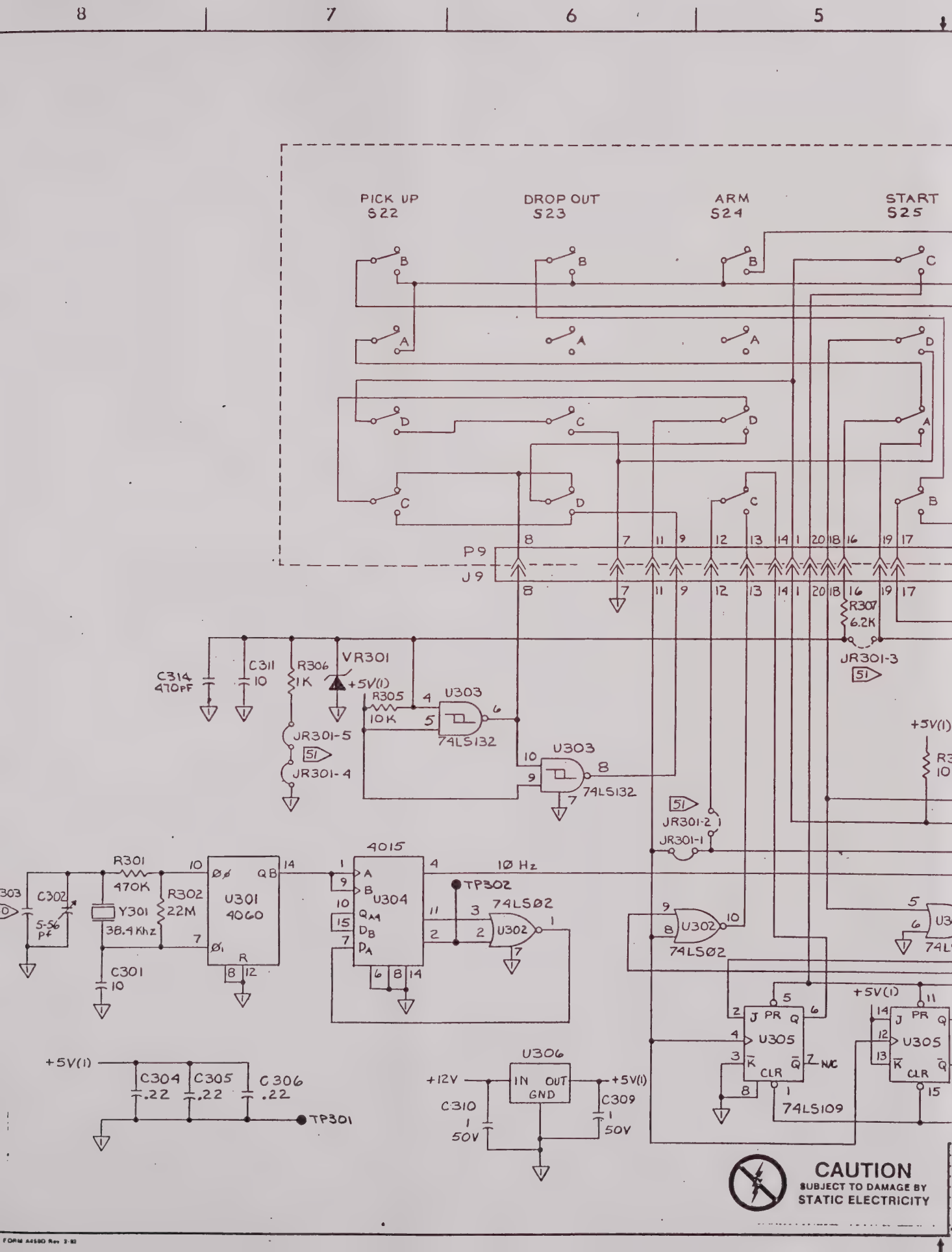
FINISH

SCHEMATIC, MAIN PCB ASSEMBLE (VOLTAGE & CURRENT SOURCES)

BASIC DWG NO. SUFFIX	DRAWING NO.	PART NO.
APPLICATION	FIRST USED ON	

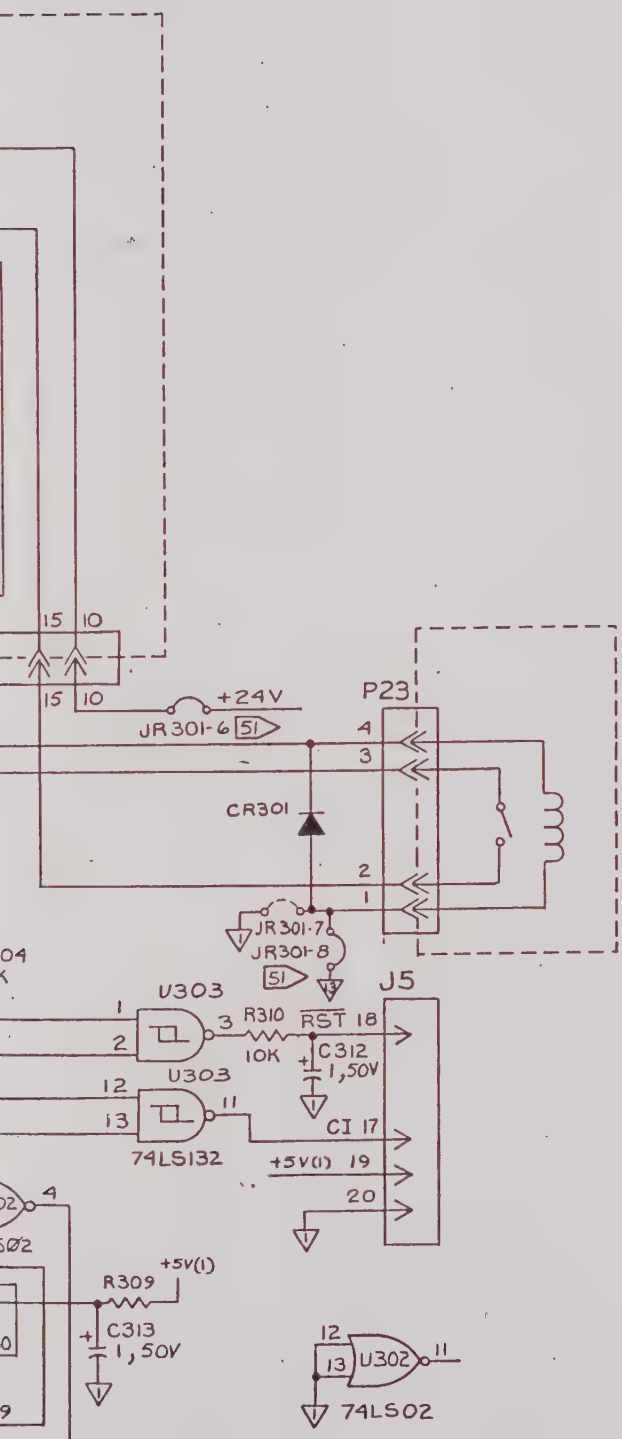
PART NO.	SIZE	DRAWING NO
—	D	A21-50-1001
SCALE —	SH 8 OF 9	REV —

DIST


8
7
6
5
PICK UP
S22
DROP OUT
S23
ARM
S24
START
S25
P9
J9
R307
6.2K
JR301-3
51
C314
470PF
C311
10
R306
1K
VR301
+5V(1)
R305
10K
U303
74LS132
JR301-5
JR301-4
JR301-2
JR301-1
R301
470K
R302
22M
C302
5-56 PF
Y301
38.4 Khz
C301
10
U301
4060
4015
U304
10 Hz
TP302
74LS02
U302
U305
74LS109
C304
.22
C305
.22
C306
.22
TP301
U306
+12V
IN
OUT
GND
C310
1
50V
C309
1
50V
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHET ONE					

A21-50-1001 REV — SH 9 OF 9



NOTES: (CONTINUED)

50 SELECTED PART

51 TIMER CONFIGURATION IS DETERMINED IN THE FACTORY AT ASSEMBLY. THE RELAY TIMER REQUIRES POSITIONS 1,4,5,6 & 8 OF JR301 TO BE SHORTED AND POSITIONS 2,3, & 7 TO BE OPENED.

REF DES	+ 5V	V
U301	16	8,12
U302	14	7,12,13
U303	14	7
U304	16	6,8,14
U305	12,13,14,16	3,8

REFERENCE DESIGNATION		
FIRST USED	LAST USED	NOT USED
C301	C311	
R301	R309	302, 303
CR301	CR301	
U301	U306	
Y301	Y301	
VR301	VR301	

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

BASIC DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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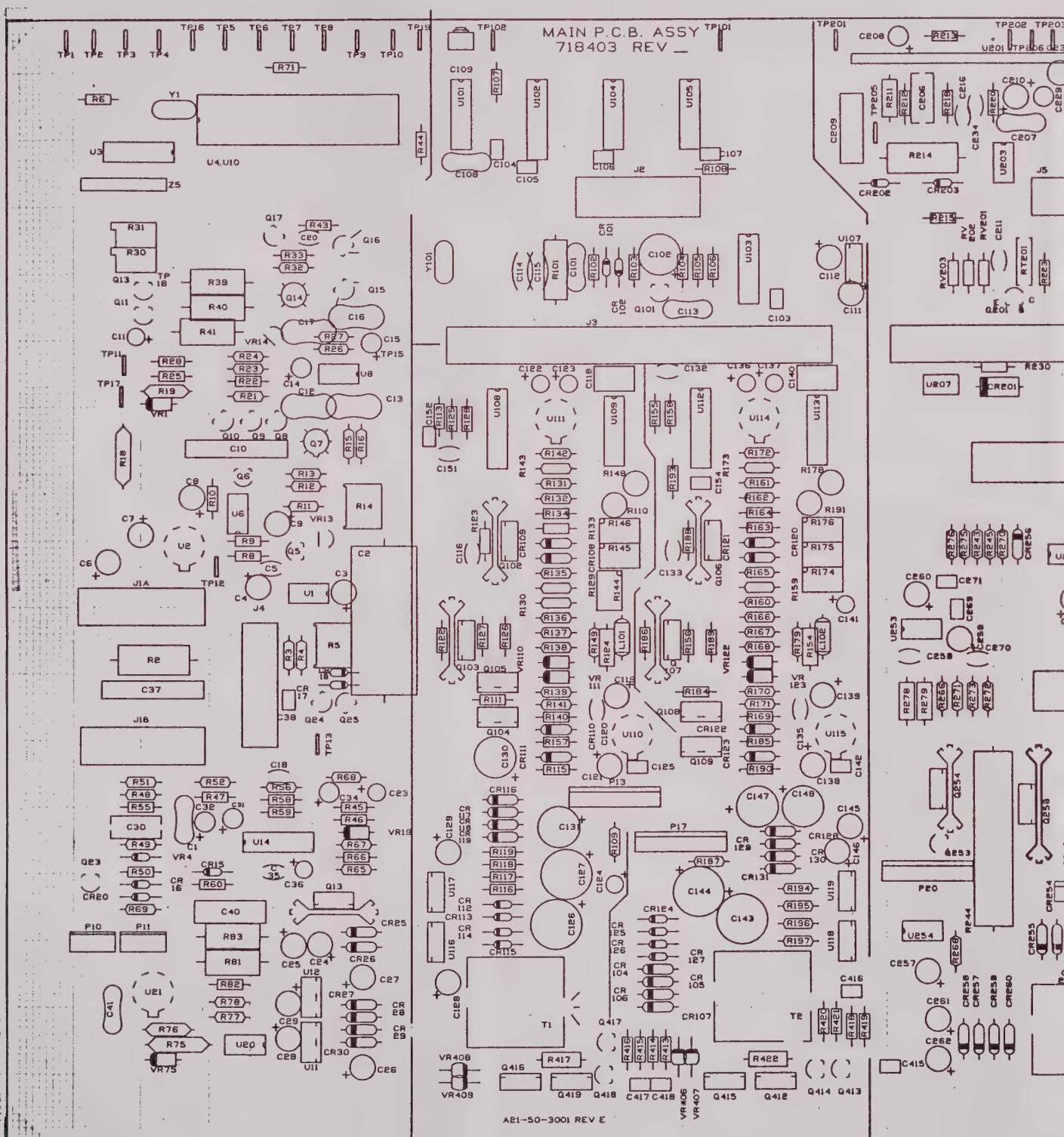
DIMENSIONS IN INCHES

DWN B. HANSON	4-10-84	SCHEMATIC, MAIN PCB ASSEMBLY (RELAY TIMER)
CHK		
PROJ ENGR T.L. ROBB	8/1/84	
MFG ENGR A.E. WEISS	7/31/84	
FINISH		PART NO. / SIZE D / DRAWING NO A21-50-1001
		SCALE — / SH 9 OF 9 / REV —

PROPRIETARY

DIST



CAUTION
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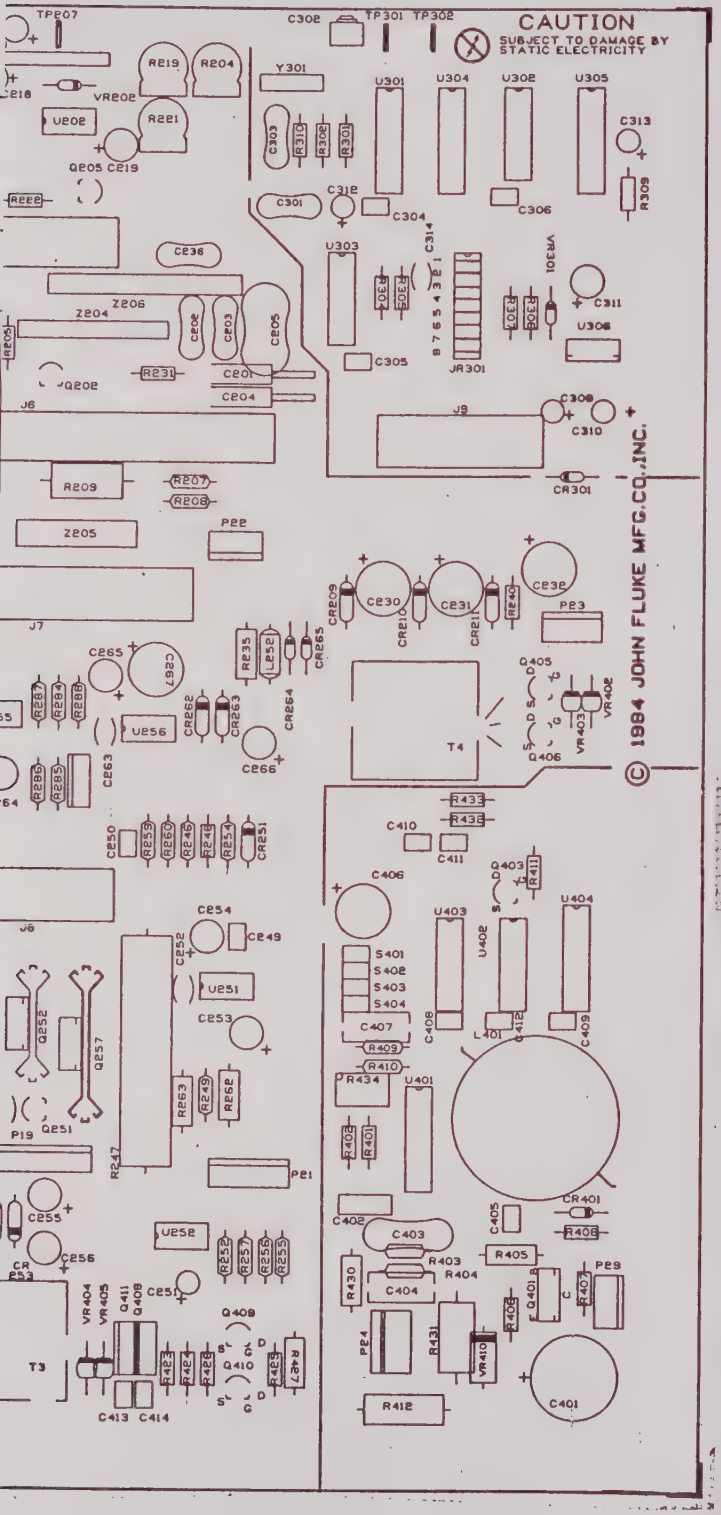
STATIC ELECTRICITY



REVISIONS					
LTR	DESCRIPTION	EFF	APPROVAL / DATE		
			DWN	CHK	PROJ ENGR / MFG ENGR
–	RELEASE TO PRODUCTION		DCB 8/3/84	[illegible]	[illegible] 8/6/84

A21-50-1601 REV – SH 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

1. SEE A21-50-1001 FOR SCHEMATIC.

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

PARTS LIST

BASIC PART NO.	DRAWING NO. SUFFIX	PART NO. FIRST USED ON APPLICATION

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EVERETT, WA 98206

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TOLERANCE: .XX = ± .XXX = ± ANGLES = ±
DIMENSIONS IN INCHES
FINISH

DWN	D.C. BARRETT	8/3/84
CHK	[illegible]	8/5/84
PROJ ENGR	T.L. ROBB	8/6/84
MFG ENGR	A.R. WEISS	8/6/84

REF. DESIGNATOR, MAIN P.C.B. ASSY

PART NO.	SIZE	DRAWING NO.
[illegible]	D	A21-50-1601

SCALE NONE SH 1 OF 1 REV –

PROPRIETARY DIST

NOTES: UNLESS OTHERWISE SPECIFIED

1. ASSEMBLE PER S.O.P. 111.8
2. SEE A21-50-1001 FOR SCHEMATIC
3. LEADS TO BE .100 LONG MAX.
4. REVISIONS TO THIS DRAWING TO BE MADE THROUGH CAD DATA BASE #673.
5. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1
6.
7.
8.
9. R113, R193
10.
11. R6,R25,R71,R108,R218,R240,R306.
12. R44,R46,R47,R60,R107,R304,R305,R309,R310,R411
13. R45,R231
14. R55,R401,R402
15. R103,R122,R123,R186,R188
16. R104,R140,R157,R169,R185
17. R133,R163
18. R128,R158,R125,R155,R205,R223
19. R212,R302
20. R134,R164,R222,R301
22. R126,R127,R156,R189
23. R413,R414,R418,R419,R423,R424,R432,R433.
24. R249,R266
25. R111,R115,R184,R190
26. R105,R415,R416,R420,R421,R425,R426
27. R33,R102,R259,R275
28. R13,R141,R143,R171,R173
29. R11,R12,R26,R27
31. R129,R130,R159,R160,R243,R246,R256,R272
32. R131,R132,R161,R162.
33. R135,R165
34. R136,R137,R166,R167
35. R138,R149,R168,R179
36. R139,R170
37. R245,R248,R254,R270
38. CR15,CR16,CR17,CR18,CR20,CR251,CR256
39.
40. CR108-111,CR120-123
41. VR402-409
42. U8,U251,U253
43. U202,U252,U254,U255

1	108	454678		I.C., PWM, 3524	U401
1	107	412999		I.C.,DIGITAL,74LS109	U305
1	106	507640		I.C.,DIGITAL,4060B	U301
1	105	355172		I.C., DIGITAL, 4001B	U402
1	104	504449		I.C.,DIGITAL,74LS132	U303
1	103	340125		I.C.,DIGITAL,4015B	U304
1	102	355198		I.C.,DIGITAL,4011UBE	U105
1	101	404681		I.C.,DIGITAL,4069UBE	U104
1	100	393058		I.C.,DIGITAL,74LS04	U103
1	99	403568		I.C.,DIGITAL,4017B	U102
1	98	643098		I.C.,DIGITALICM7207A	U101
1	97	473389		I.C.,DIGITAL,74C906	U3
1	96	418780		I.C.,LINEAR,LF351N	U203
4	95	472845		I.C.,LINEAR,VOLT-REF,2.5V	43.
1	94	387233		I.C.,LINEAR,LM339N	U14
1	93	418566		I.C.,LINEAR,LM358N	U256
3	92	478032		I.C.,LINEAR,MC4558	42.
1	91	472779		I.C.,LINEAR,LF356N	U6
1	90	352195		I.C.,LINEAR,LM311	U1
1	89	393041		I.C.,DIGITAL,74LS02	U302
1	88	340117		I.C., DIGITAL, 4013A	U403
1	87	381830		I.C., DIGITAL, 4050B	U404
	86				
	85				
8	84	186163		DIODE,ZENER,36V	41.
8	83	453399		DIODE,1N4007	40.
	82				

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

7	81	203323		DIODE, 1N4448	38
	80				
	79				
	78				
	77				
4	76	706176		RES.,MF,1/8W,1%,39.2K	37
1	75	719823		RES.,MF,1/8W,1%,20K	R403
1	74	719559		RES.,MF,1/8W,1%,1.21K	R404
	73				
1	72	461970		RES.,MF,1/8W,.1%,90Ω	R208
1	71	461988		RES.,MF,1/8W,.1%,900Ω	R207
2	70	714923		RES.,MF,1/8W,1%,4.99K	36
4	69	272153		RES.,MF,1/8W,1%,43.2K	35
4	68	720342		RES.,MF,1/8W,1%,5.11K	34
2	67	234963		RES.,MF,1/8W,1%,19.1K	33
4	66	720276		RES.,MF,1/8W,1%,4.75K	32
8	65	719476		RES.,MF,1/8W,1%,10K	31
1	64	235283		RES.,MF,1/8W,1%,309K	R65
1	63	706119		RES.,MF,1/8W,1%,226K	R69
1	62	288530		RES.,MF,1/8W,1%,64.9K	R68
	61				
1	60	719609		RES.,MF,1/8W,1%,133K	R52
1	59	720482		RES.,MF,1/8W,1%,681K	R49
1	58	241083		RES.,MF,1/8W,1%,150K	R48
1	57	237230		RES.,MF,1/8W,1%,61.9K	R77
4	56	352245		RES.,MF,1/8W,.1%,10.02K	29
1	55	719872		RES.,MF,1/8W,1%,221Ω	R24
1	54	719898		RES.,MF,1/8W,1%,22.1K	R23
1	53	719864		RES.,MF,1/8W,1%,215K	R21
1	52	719732		RES.,MF,1/8W,1%,169K	R16
1	51	720318		RES.,MF,1/8W,1%,49.9Ω	R15
5	50	719468		RES.,MF,1/8W,1%,1K	28
	49				
	48				
	47				
	46				
1	45	572594		RES.,CC,1/4W,5%,68Ω	R407
1	44	572792		RES.,CC,1/4W,5%,2M	R82
4	43	572842		RES.,CC,1/4W,5%,10M	27
	42				
	41				
	40				
	39				
1	38	573337		RES.,CF,1/4W,5%,5.6K	R106
7	37	573071		RES.,CF,1/4W,5%,270Ω	26
4	36	573444		RES.,CF,1/4W,5%,20K	25
1	35	573345		RES.,CF,1/4W,5%,6.2K	R307
2	34	573055		RES.,CF,1/4W,5%,200Ω	24
1	33	573600		RES.,CF,1/4W,5%,150K	R28
1	32	641357		RES.,CF,1/4W,5%,27Ω	R408
8	31	573485		RES.,CF,1/4W,5%,33K	23
4	30	572941		RES.,CF,1/4W,5%,10Ω	22
2	29	573352		RES.,CF,1/4W,5%,6.8K	9
1	28	573311		RES.,CF,1/4W,5%,4.7K	R230

REVISIONS

A21-50-4001AT SH 2 OF 2 REV B	LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	A	DELETED ITEM 5 & 17. REV CKTY ITEM 1.		DCB 4/27/84			
	B	REV CKTY. QTY ITEM 7 WAS 11. DEL "R308" & ITEM 82	DCO 19468	DCB 7/23/84			
	—	RELEASE TO PRODUCTION		DCB 7/23/84	8/1/84	8/1/84	7/27/84

4	27	573675		RES.,CF,1/4W,5%,470K	20
1	26	342659		RES.,CF,1/4W,5%,2.2M	R220
1	25	641043		RES.,CF,1/4W,5%,15Ω	R215
1	24	572883		RES.,CF,1/4W,5%,1Ω	R213
2	23	572859		RES.,CF,1/4W,5%,22M	19
1	22	573014		RES.,CF,1/4W,5%,100Ω	R406
6	21	573691		RES.,CF,1/4W,5%,1M	18
2	20	573428		RES.,CF,1/4W,5%,15K	17
5	19	573154		RES.,CF,1/4W,5%,680Ω	16
5	18	574244		RES.,CF,1/4W,5%,220Ω	15
	17				
2	16	573501		RES.,CF,1/4W,5%,39K	R59,66
1	15	573535		RES.,CF,1/4W,5%,51K	R58
3	14	573329		RES.,CF,1/4W,5%,5.1K	14
1	13	573527		RES.,CF,1/4W,5%,47K	R50
2	12	573584		RES.,CF,1/4W,5%,100K	13
1	11	573402		RES.,CF,1/4W,5%,12K	R22
1	10	573477		RES.,CF,1/4W,5%,27K	R10
1	9	573519		RES.,CF,1/4W,5%,43K	R9
1	8	573287		RES.,CF,1/4W,5%,3.3K	R8
10	7	573394		RES.,CF,1/4W,5%,10K	12
7	6	573170		RES.,CF,1/4W,5%,1K	11
	5				
	4				
	3				
	2				
1	1	718411	A21-50-3001	P.C.B., MAIN ASSEMBLY	
QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

BASIC WG NO. SUFFIX	DRAWING NO	PART NO.
	A21-50-4001	718403
APPLICATION	FIRST USED ON	

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P.O. BOX C9090
EVERETT, WA 98206

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UNLESS OTHERWISE SPECIFIED
TOLERANCE: .XX = ± .XXX = ± ANGLES = ±
DIMENSIONS IN INCHES
FINISH

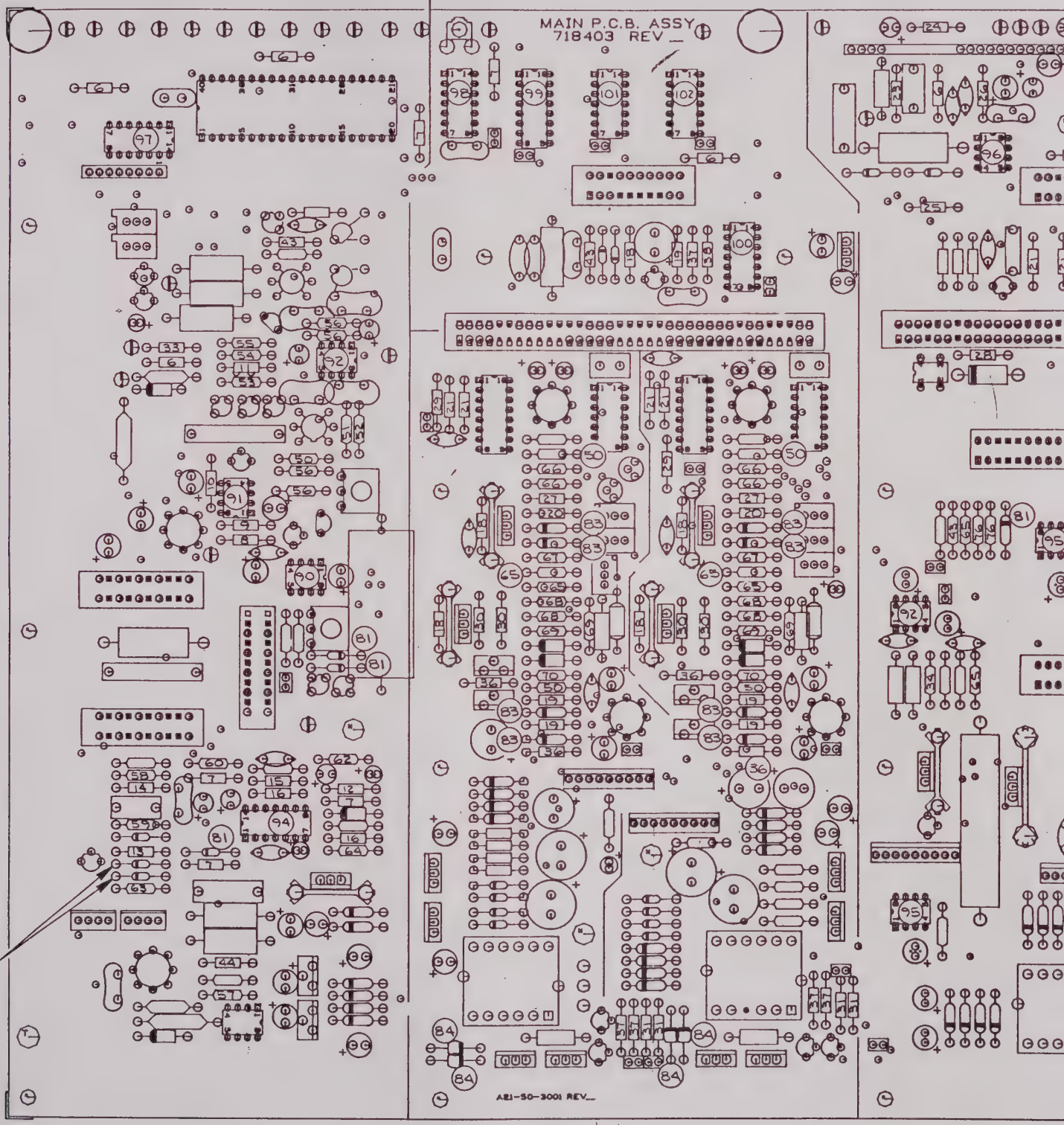
DWN	D.C. BARRETT	3/20/84
CHK		8/8/84
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. WISS	7/27/84

ASSEMBLY, MAIN P.C.B. (AUTO-INSERTED)

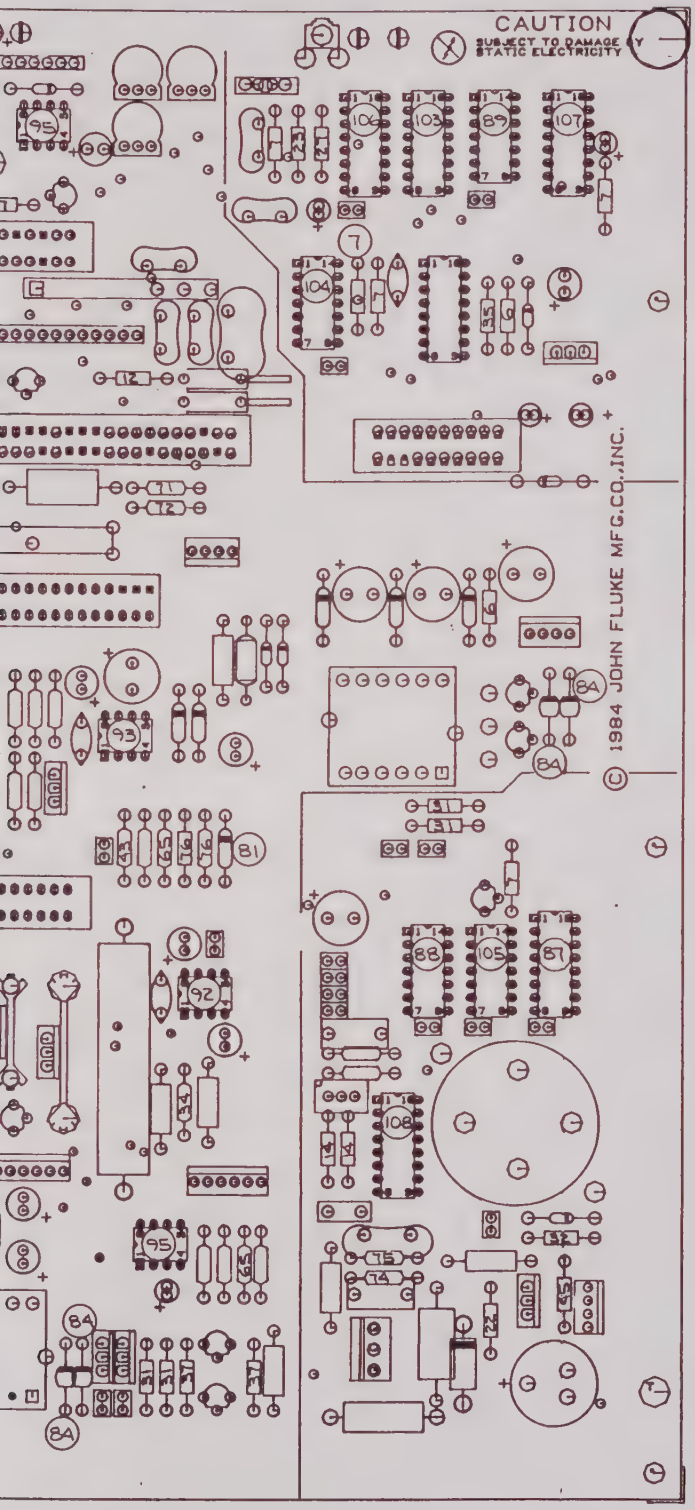
PART NO.	SIZE	DRAWING NO
718429	D	A21-50-4001AT
SCALE —	SH 1 OF 2	REV B

PROPRIETARY

DIST



CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY



A21-50-4001 AI REV B SH 2 OF 2

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

SEE SHEET 1 FOR NOTES & PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

PARTS LIST

SIC	A21-50-4001	718403
NO.	DRAWING NO.	PART NO.
FFIX	FIRST USED ON	
	APPLICATION	

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89536

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED

TOLERANCE: XX = ± ; XXX = ± ; ANGLES = ±

DIMENSIONS IN INCHES

DWN	D.C. BARRETT	7/25/84
CHK		
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. WEISS	7/27/84
FINISH		

ASSEMBLY, MAIN P.C.B.
(AUTO-INSERTED)

PART NO.	SIZE	DRAWING NO.
718429	D	A21-50-4001 AI

SCALE 1.5 : 1 | SH 2 OF 2 | REV B

PROPRIETARY

DIST

NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAMS SEE A21-50-1001.
2. ASSEMBLE PER S.O.P. 111.8.
3. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INK STAMP (PERMA-DRI 177 OR EQUIVALENT).
4. LEAD LENGTH .100 MAX.
5. C303 TO BE SELECTED IN TEST.
6. CLOCK ITEM 11 WITH PAINTED POLARIZING DOT FACING Q15. DISREGARD TAB ON ITEM 11.
7.
8. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1
9.
10. PREP OFF P.C.B. .300" MAX, 2 PLACES.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20. VR1, R18 (1/2W) & R19 (1/4W) MATCHED SET.
    VR75, R75 (1/2W) & R76 (1/4W) MATCHED SET
21. R262, R278
22. R263, R279
23. R417, R422, R427
24. R124, R154
25. R260, R276
26. R116, R119, R194, R197
27. R117, R118, R195, R196
28. R78, R410
29. R252, R268
30. R284, R285
31. R67, R288
32. R109, R187
33. R142, R172
34. R257, R273
35. R255, R271
36. C35, C402
37. R244, R247
38. R3(100K), R4(11.8K) MATCHED SET
39. R39(52K), R40(9K), R41(1K) MATCHED SET
40. R148, R178
41. R110, R191
42. R146, R176, R434
43. R144, R145, R174, R175.
44. RV201, RV202, RV203
45. C252, C258 ,C18, C120, C135
46. C14, C15, C229
47. C3, C4, C6, C7, C8, C9
48. C24-C29, C111, C112, C119, C121, C128, C129, C138, C139, C145, C146, C219, C253-C256, C259-C262, C265, C266, C311
49. C102, C130, C131, C147, C148, C230, C231, C232
50. C11, C23, C36, C122, C123, C124, C136, C137, C141, C251, C257, C264, C309, C310, C312, C313
51. C10, C37
52. C12, C13, C16, C17
53. C30, C206
54. C38, C103-C107, C304, C305, C306, C408, C409, C250, C271
55. C109, C302
56. C116, C133
57. C248, C263, C270
58. C125, C142
59. C126, C127, C143, C144
60. C203, C207
61. C201, C204
62. C208, C233
63. C20, C211, C216, C234
64. C405, C410, C411, C413-C418, C249, C269
65. C113, C301
66. C132, C151, C314.
67. C118, C140
68. C152, C154
69. C114, C115
70. C31, C32, C34
71. CR101, CR102
72. VR110, VR111, VR122, VR123
73. CR112-CR115, CR124-CR127, CR264, CR265
74. CR202, CR203
75. CR301, CR401
76. Q252, Q254, Q257, Q258
77. Q5, Q23, Q201, Q202, Q251, Q255
78. Q6, Q8, Q11, Q13, Q15
79. Q9, Q16, Q17, Q24, Q25
80. Q403, Q409, Q410, Q413, Q414, Q417, Q418, Q405, Q406
81. Q102, Q105, Q106, Q108
82. Q103, Q104, Q107, Q109
83. Q408, Q411, Q412, Q415, Q416, Q419
84. U117, U119
85.
86.
87.
88.
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96.
97.

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

U116, U118

U2, U111, U114

U13, U107, U306

U109, U113

U108, U112

U110, U115

L101, L102

S401-S404

P10, P11, P22, P23, P29

P13, P17, P19, P20

J1A, J1B, J2, J4, J5, J8, J9

TP1-TP13, TP15-TP19, TP101, TP102, TP201, TP202, TP203, TP205, TP207, 301, 302

CR25-30, 104-107, 116-119, 128-131, 209, 210, 211, 252-255, 257-260, 262, 263.

A21-50-4001 REV B SH 1 OF 4

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
A	ADDED FLAG NOTE 10. QTY ITEM 85 WAS 2. QTY ITEM 101 WAS 11. QTY ITEM 103 WAS 1. DEL ITEM 105 ADDED ITEM 219.		DCB 4/27/84			AKW 7/27/84
B	QTY ITEM 124 WAS 2. QTY ITEM 213 WAS 25. ADDED ITEM 137. P/N ITEM 215 WAS 256156. P/N ITEM 217 WAS 110395. DEL. ITEM 216.	DCO# 19468	DCB 7/13/84			AKW 7/27/84
–	RELEASE TO PRODUCTION		DCB 7/20/84	8/1/84	8/1/84	AKW 7/27/84

PARTS LIST CONT'D SHEET 2

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES
2	54	733469		RES.,WW,10W,5%,25Ω	37.
1	53	659060		RES.,WW,2W,10%,.04Ω	R431
1	52	461939		RES.,WW,1/8W,1%,100Ω	R83
1	51	461921		RES.,WW,1/8W,1%,6.2K	R81
	50				
1	49	268789		RES.,MF,1/8W,1%,10Ω	R32
2	48	168286		RES.,MF,1/8W,1%,30.1K	35.
2	47	221663		RES.,MF,1/8W,1%,9.09K	34.
2	46	379040		RES.,MF,1/8W,1%,9.31K	33.
2	45	328013		RES.,MF,1/8W,1%,261Ω	32.
1	44	241471		RES.,MF,1/8W,1%,27.4K	R409
2	43	293472		RES.,MF,1/8W,1%,100K	31.
1	42	347070		RES.,MF,1/8W,1%,18.2K	R287
1	41	288522		RES.,MF,1/8W,1%,511K	R286
2	40	309757		RES.,MF,1/8W,1%,51.1K	30.
2	39	241380		RES.,MF,1/8W,1%,97.6K	29.
2	38	268417		RES.,MF,1/8W,1%,6.81K	28.
1	37	293605		RES.,MF,1/8W,1%,10.2K	R56
1	36	241372		RES.,MF,1/8W,1%,38.3K	R51
4	35	289983		RES.,MF,1/8W,1%,2.61K	27.
4	34	328005		RES.,MF,1/8W,1%,237Ω	26.
2	33	291393		RES.,MF,1/8W,1%,33.2K	25.
	32				
2	31	161406		RES.,CC,1/2W,10%,3.9K	24.
1	30	109389		RES.,CC,1W,10%,10K	R412
1	29	187880		RES.,CC,1/2W,5%,5.6K	R235
3	28	159616		RES.,CC,1/2W,5%,270Ω	23.
1	27	109124		RES.,CC,1/2W,5%,560Ω	R430
2	26	109165		RES.,CC,1/2W,5%,10K	22
1	25	170704		RES.,CC,1/2W,5%,910Ω	R405
2	24	246793		RES.,CC,1/2W,5%,1.5Ω	21.
	23				
1	22	285056		RES.,CC,2W,5%,100K	R214
1	21	108233		RES.,CC,1/2W,10%,22M	R211
1	20	109397		RES.,CC,1W,10%,100K	R101
1	19	221606		RES.,CC,1/4W,5%,16K	R43
1	18	110015		RES.,CC,2W,10%,47K	R2
	17				
	16				
	15				
2	14	515635	8050A-2007	SUPPORT, HYBRID	
	13				
1	12	480897	53-5026	HYBRID,RMS CONVERTER	U201
1	11	476911	2180A-4501	DUAL FET, SELECTED	Q14
2	10	377283	8600A-4502	ZENER REFERENCE SET	20.
1	9	490888	2030A-6402	CHOKE	L401
1	8	735100	A21-50-6304	TRANSFORMER,INVERTER	T4
1	7	735092	A21-50-6303	TRANSFORMER, INVERTER	T3
1	6	618488	A21-44-6302	TRANSFORMER, INVERTER	T2
1	5	618470	A21-44-6301	TRANSFORMER, INVERTER	T1
	4				
	3				
	2				
1	1	718429	A21-50-4001AI	ASSY,MAIN P.C.B.(AI)	

PARTS LIST

2590A	2590A-5001	717595
BASIC	A21-50-5001	716233
WG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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DIMENSIONS IN INCHES

DWN	D.C. BARRETT	3/26/84
CHK		8/8/84
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. Weiss	7/27/84
FINISH		

ASSEMBLY, MAIN P.C.B.

PART NO.	SIZE	DRAWING NO
718403	D	A21-50-4001
SCALE —	SH 1 OF 4	REV B

PROPRIETARY

DIST

	223				
	222				
	221				
7	220	393785		P-NUT,#6-32	
	219				
4	218	155473		SPACER,CERAMIC,1/2"	
9	217	146225		WASHER, FLAT, #4	
	216				
9	215	745869		PUSH-RIVIT, PLASTIC	
1	214	380022		CONN.,HEADER,3POS	P24
27	213	512889		CONNECTOR,TEST POINT	96.
1	212	520148		CONN.,EDGE,44 POS	J7
7	211	520189		CONN.,EDGE,20 POS	95.
2	210	631309		CONN.,EDGE,72 POS	J3,6
4	209	631168		CONN.,POST HEADER,9 POS	94.
1	208	631176		CONN.,POST HEADER,6 POS	P21
5	207	631184		CONN.,POST HEADER,4 POS	93.
1	206	429282		SOCKET, 40 PIN DIP	
2	205	276535		SOCKET,16 PIN DIP	
2	204	370304		SOCKET,14 PIN DIP	
1	203	495507		HEADER,PROGRAMMED	JR301
2	202	386235		HEATSINK	
7	201	524934		HEATSINK,TO-220	
4	200	733808		SWITCH,SPST	92.
	199				
	198				
1	197	519173		CRYSTAL,38.4KHZ	Y301
1	196	643056		CRYSTAL,5.24288MHZ	Y101
1	195	474072		CRYSTAL,4MHZ	Y1
	194				
	193				
	192				
	191				
1	190	174755		CHOKE,100uH	L252

	189				
2	188	363150		INDUCTOR,560uH	91.
	187				
	186				
	185				
1	184	418582		I.C.,DIODE BRIDGE,VM08	U207
	183				
	182				
	181				
	180				
2	179	381889		I.C.,LINEAR,LM201A	90.
2	178	643072		I.C.,LINEAR,ICL 8063MJE	89.
2	177	643080		I.C.,LINEAR,ICL 8038	88.
1	176	225961		I.C.,LINEAR,AD3092	U21
3	175	428847		I.C.,VOLT.REG.,7805	87.
1	174	413187		I.C.,VOLT.REG.,7815	U12
1	173	413179		I.C.,VOLT.REG.,7915	U11
1	172	413740		I.C.,LINEAR,LM307	U20
3	171	429837		I.C.,LINEAR,LF358	86.
2	170	460410		I.C.,VOLT.REG.,ADJ. LM317	85.
2	169	707661		I.C.,VOLT.REG.,ADJ. LM337	84.
	168				
	167				
6	166	477331		TRANSISTOR,NPN,MPSU01A	83.
1	165	325753		TRANSISTOR,PNP,D45C5	Q401
1	164	381731		TRANSISTOR,NPN,MPSU10	Q255
1	163	195974		TRANSISTOR,PNP,2N3906	Q205
4	162	685453		TRANSISTOR,PNP,TIP-30C	82.
4	161	685446		TRANSISTOR,NPN,TIP-31C	81.
9	160	640516		TRANSISTOR,FET,VN10KM	80.
1	159	403634		TRANSISTOR,FET	Q101
5	158	343830		TRANSISTOR,FET	79.
1	157	419283		TRANSISTOR,DUAL FET	Q7
5	156	376475		TRANSISTOR,FET	78.
6	155	218396		TRANSISTOR,NPN,2N3904	77.
1	154	429977		TRANSISTOR,FET	Q10
4	153	386128		TRANSISTOR,NPN,TIP-20	76.
	152				
	151				
	150				
1	149	650358		DIODE,T.V.S.,36V,1N5646	VR410
1	148	181073		DIODE,ZENER,22V,1N969B	VR4
1	147	180455		DIODE,ZENER,4.3V,1N749A	VR202
2	146	483701		DIODE,5FF10	75.
2	145	348177		DIODE,SI,FD7223	74.
1	144	347559		DIODE,SI,1N5400	CR201
10	143	495739		DIODE,3FF10	73.
4	142	357848		DIODE,ZENER,64.V,1N4578	72.
2	141	381806		DIODE,SI,1N3062	71.
1	140	393579		DIODE,ZENER,6.4 V,1N4567	VR19
2	139	348482		DIODE,CURRENT REG.	VR13, 14
1	138	277236		DIODE,ZENER,5.6V,1N752A	VR301
31	137	379412		DIODE, SILICON, 1N4933	97
	136				

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

	135				
1	134	512848		CAP.,CERAM,100V,100pF	C412
3	133	161919		CAP.,TANT,35V,1uF	70.
2	132	355420		CAP.,CERAM,1KV,.05uF	69.
2	131	358275		CAP.,CERAM,100V,470pF	68.
	130				
1	129	148494		CAP.,MICA,500V,100pF	C236
1	128	192518		CAP.,MICA,500V,3300pF	C205
1	127	148452		CAP.,MICA,500V,270pF	C202
2	126	739987		CAP.,POLY,50V,.0047uF	67.
1	125	148387		CAP.,MICA,500V,1000pF	C403
3	124	368613		CAP.,CERAM,1KV,470pF	66.
1	123	216986		CAP.,MICA,500V,8pF	C108
1	122	175224		CAP.,MICA,500V,12pF	C101
2	121	175216		CAP.,MICA,500V,10pF	65.
1	120	435113		CAP,POLY,100V,.22uF	C404
1	119	393439		CAP.,POLY,100V,.1uF	C407
1	118	494575		CAP.,ALUM,25V,470uF	C406
11	117	407361		CAP.,CERAM,100V,.01uF	64.
1	116	512657		CAP.,ALUM,100V,190uF	C401
1	115	614362		CAP.,ALUM,50V,22uF	C267
1	114	161927		CAP.,TANT,20V,2.2uF	C218
4	113	149153		CAP.,CERAM,100V,.01uF	63.
1	112	436840		CAP.,ALUM,35V,22uF	C210
1	111	448183		CAP.,POLY,1KV,.022uF	C209
2	110	193623		CAP.,TANT,15V,10uF	62.
2	109	435016		CAP.,VARI,1.7KV,.25-1.5pF	61.
2	108	148478		CAP.,MICA,500V,150pF	60
4	107	641225		CAP.,ALUM,100V,100uF	59
2	106	354852		CAP.,CERAM,50V,33pF	58
	105				
2	104	357806		CAP.,CERAM,500V,1000pF	56
3	103	148924		CAP.,CERAM,25V,.05uF	57
2	102	404301		CAP.,VARI,250V,6-50pF	55
13	101	519157		CAP.,CERAM,50V,.22uF	54
1	100	369124		CAP.,POLY,100V,.47uF	C40
1	99	160317		CAP.,MICA,500V,33pF	C41
2	98	309849		CAP.,CERAM,50V,.22uF	36
2	97	162008		CAP.,POLY,250V,.047uF	53
	96				
4	95	177980		CAP.,MICA,500V,430pF	52
2	94	306522		CAP.,POLY,100V,2.2uF	51
1	93	106732		CAP.,CERAM,500V,.0012uF	C5
16	92	602342		CAP.,ALUM,50V,1uF	50
8	91	603977		CAP.,ALUM,35V,47uF	49
28	90	603985		CAP.,ALUM,35V,10uF	48
6	89	614024		CAP.,ALUM,35V,15uF	47
3	88	330662		CAP.,TANT,20V,10uF	46
1	87	364042		CAP.,POLY,50V,.47uF	C2
1	86	148536		CAP.,MICA,500V,47pF	C1
5	85	175232		CAP.,CERAM,100V,.005uF	45
	84				
	83				
	82				

A21-50-4001 SHT 2 OF 4 REV B

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES
1	81	474999		RES. NET.,CUSTOM	Z204
1	80	461491		RES. NET.,1Ω,.9 Ω	Z205
1	79	461483		RES. NET.,	Z206
1	78	413286		RES.NET.,8 PIN SIP,47K	Z5
	77				
	76				
1	75	446849		THERMISTOR	RT201
	74				
3	73	447672		VARISTOR, 10%, 430V	44.
	72				
1	71	720995		RES.,VARI,20T,500Ω	R30
1	70	485052		RES.,VARI,1T,1M	R221
1	69	478883		RES.,VARI,1T,5K	R219
1	68	474973		RES.,VARI,1T,200Ω	R204
4	67	381921		RES.,VARI,20T.200K	43.
3	66	393728		RES.,VARI,20T.1K	42.
2	65	193045		RES.,VARI,1T,100K	41.
2	64	193060		RES.,VARI,1T,1K	40.
1	63	474387		RES.,VARI,1T,500K	R14
1	62	275743		RES.,VARI,1T,200Ω	R5
1	61	721001		RES.,VARI,20T,25K	R31
	60				
1	59	375782		RES.,SET,MF,MATCHED	39.
1	58	479030		RES.,SET,MF,MATCHED	38.
	57				
	56				
1	55	461962		RES.,WW,3W,.15%,9Ω	R209

PARTS LIST

2590A	2590A-5001	717593
BASIC	A21-50-5001	716233
DWG NO. SUFFIX	DRAWING NO.	PART NO.
APPLICATION	FIRST USED ON	

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FLUKE 89536

JOHN FLUKE MFG. CO., INC.
P.O. BOX C9090
EVERETT, WA. 98206

DO NOT SCALE DRAWING

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TOLERANCE .XX = ± .XXX = ± ANGLES ±
DIMENSIONS IN INCHES

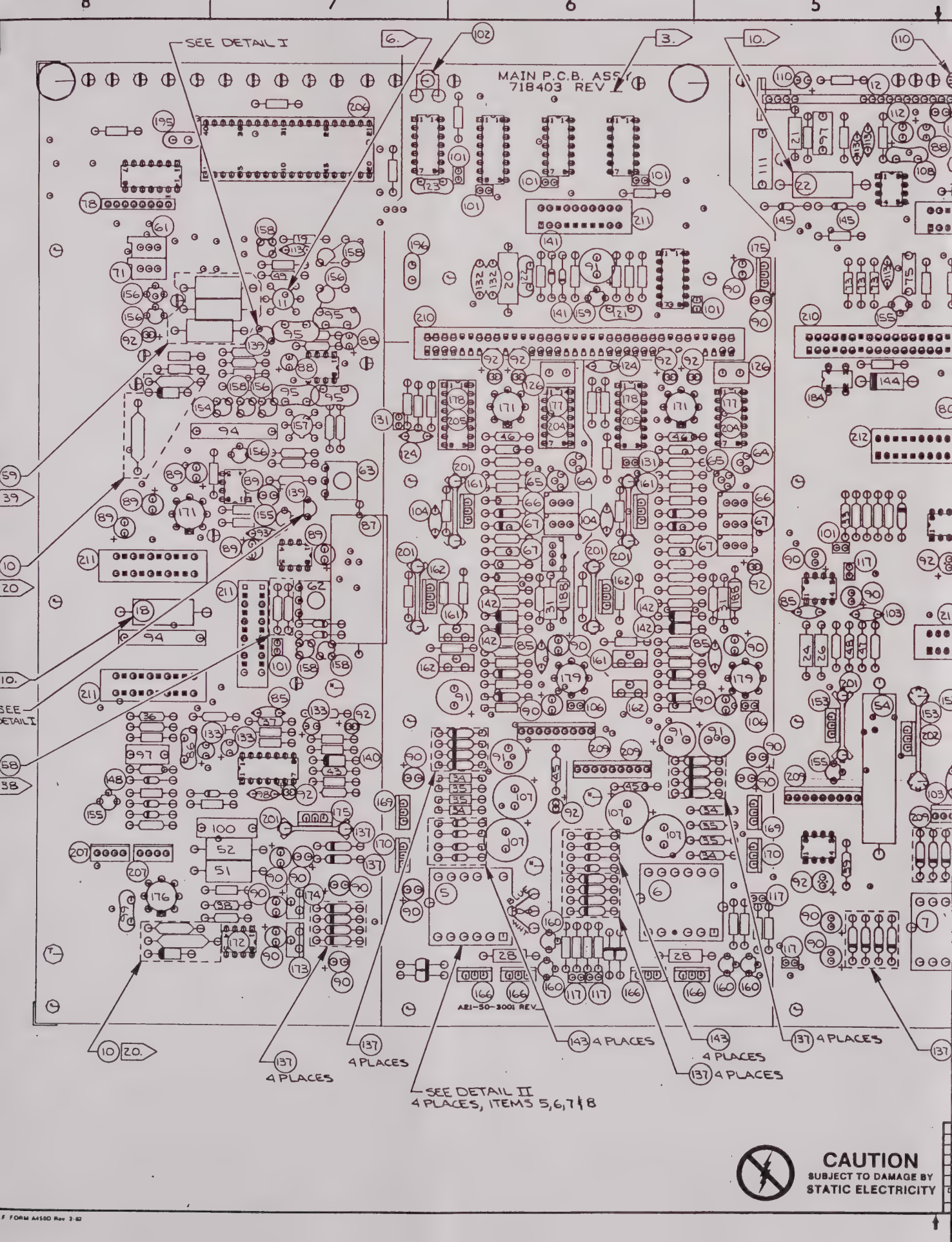
DWN	D.C. BARRETT	3/26/84
CHK		
PROJ ENGR	T.L. ROBB	8/16/84
MFG ENGR	A.K. WEIKS	7/27/87
FINISH		

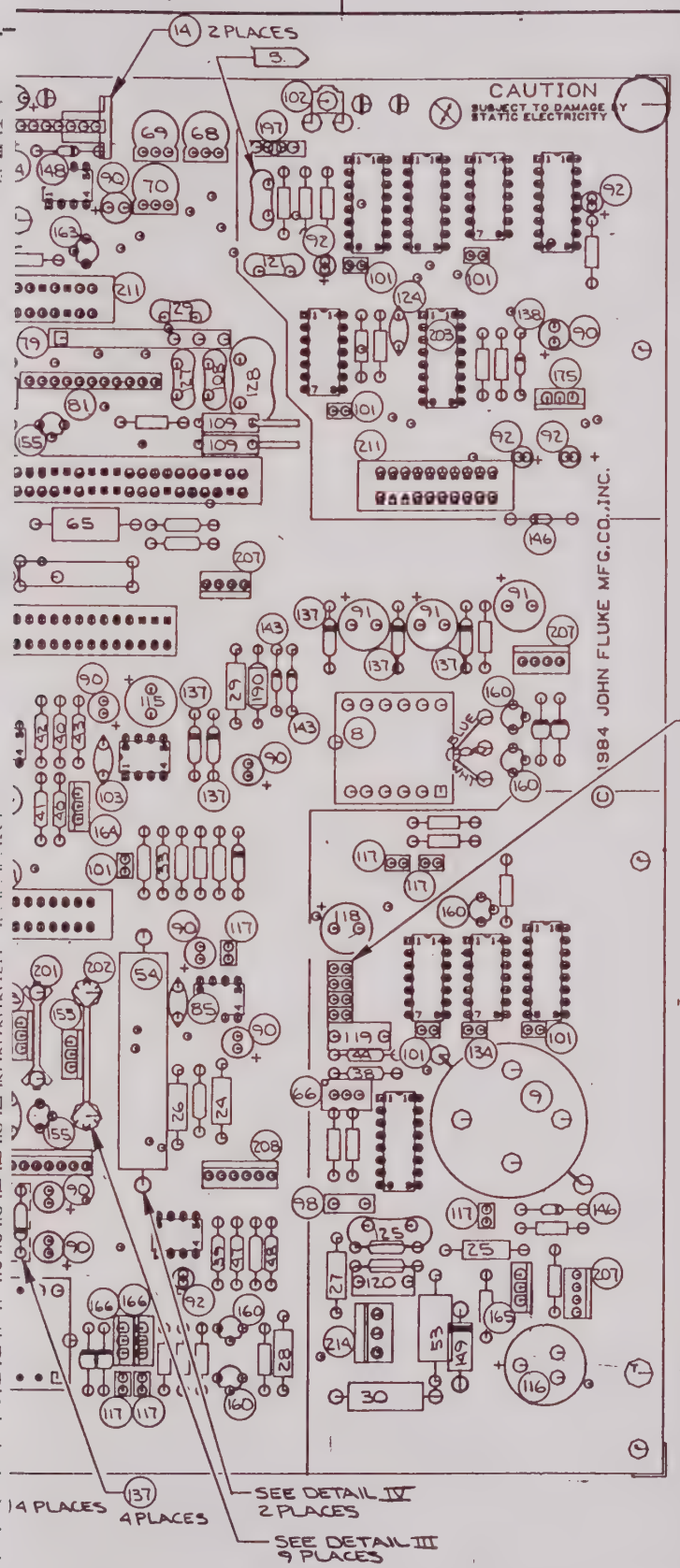
ASSEMBLY
MAIN P.C.B.

PART NO.	SIZE	DRAWING NO.
718403	D	A21-50-4001
SCALE —	SH 2 OF 4	REV B

PROPRIETARY

DIST


MAIN P.C.B. ASSY
718403 REV L
SEE DETAIL I
SEE DETAIL II
4 PLACES, ITEMS 5,6,7 & 8
4 PLACES
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY



REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

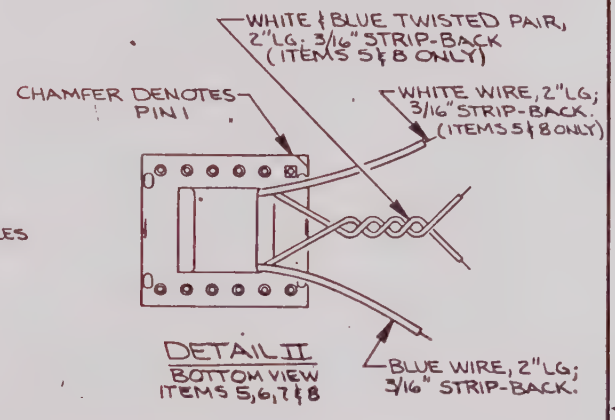
A21-50-4001 SH 3 OF 4 REV B

PLASTIC PACKAGE

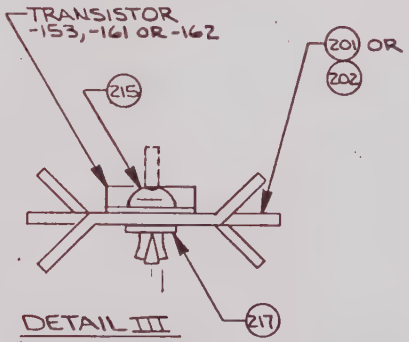
METAL PACKAGE

CLOCKING DETAIL

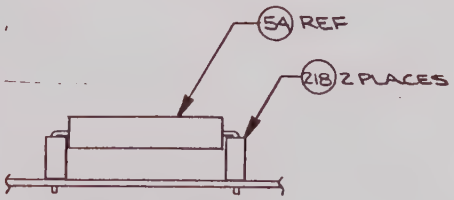
DETAIL I
2 PLACES


WHITE & BLUE TWISTED PAIR, 2"LG. 3/16" STRIP-BACK (ITEMS 5 & 8 ONLY)
CHAMFER DENOTES PIN 1
WHITE WIRE, 2"LG; 3/16" STRIP-BACK. (ITEMS 5 & 8 ONLY)
BLUE WIRE, 2"LG; 3/16" STRIP-BACK.

DETAIL II
BOTTOM VIEW
ITEMS 5,6,7 & 8



DETAIL III
TYPICAL 9 PLACES



DETAIL IV
TYPICAL 2 PLACES

SEE SHEET 1 FOR PARTS LIST

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

E580A	E580A-5001	717585
BASIC	A21-50-5001	718233
TWO NO SUFFIX	DRAWING NO	PART NO.
	FIRST USED ON	
	APPLICATION	

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EVERETT, WA. 98206

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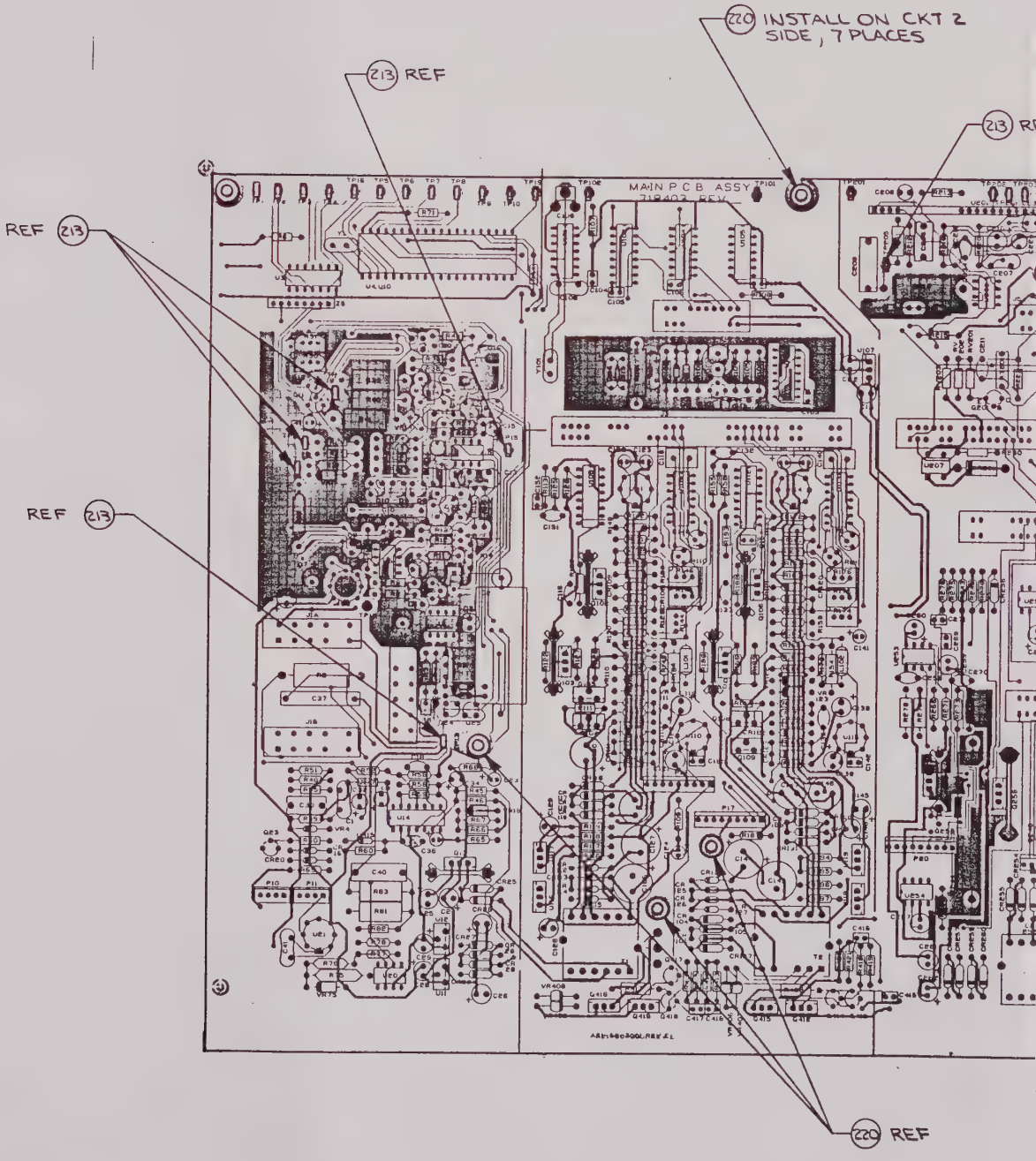
DIMENSIONS IN INCHES

DWN	D.C. BARRETT	7/25/84
CHK		
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. DAVIS	7/27/84
FINISH		

ASSEMBLY, MAIN P.C.B.

PART NO.	SIZE	DRAWING NO.
718403	D	A21-50-4001
SCALE 1.5:1	SH 3 OF 4	REV B

PROPRIETARY



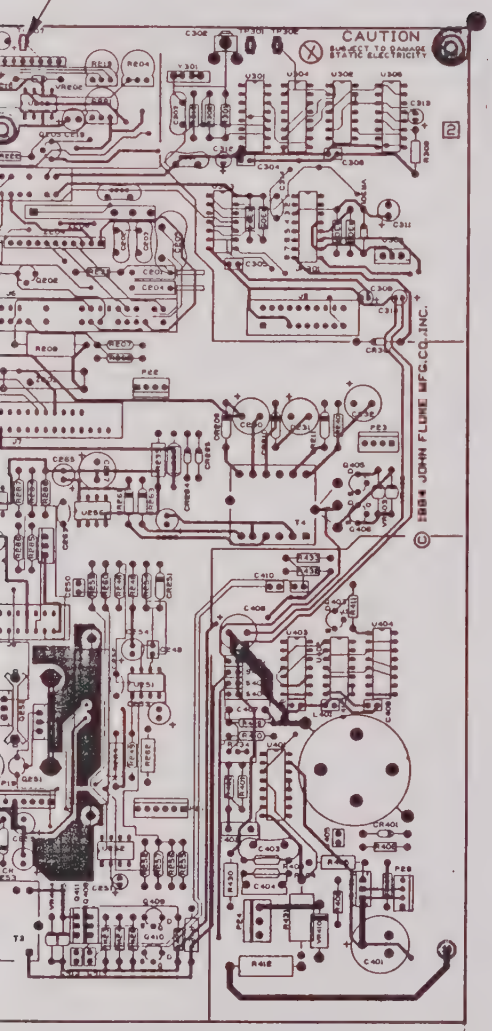
CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

A21-50-4001 REV B SH 4 OF 4

(213) 27 PLACES



SEE SHEET 1 FOR PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

2590A	2590A-5001	711595
BASIC	A21-50-5001	716733
DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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TOLERANCE: XX = ± XXX = ± ANGLES = ±
DIMENSIONS IN INCHES
FINISH

DWN D.C. BARRETT	3/23/84	
CHK		
PROJ ENGR T.L. ROBB	8/1/84	
MFG ENGR A.K. WEISS	7/27/84	

ASSEMBLY, MAIN P.C.B.

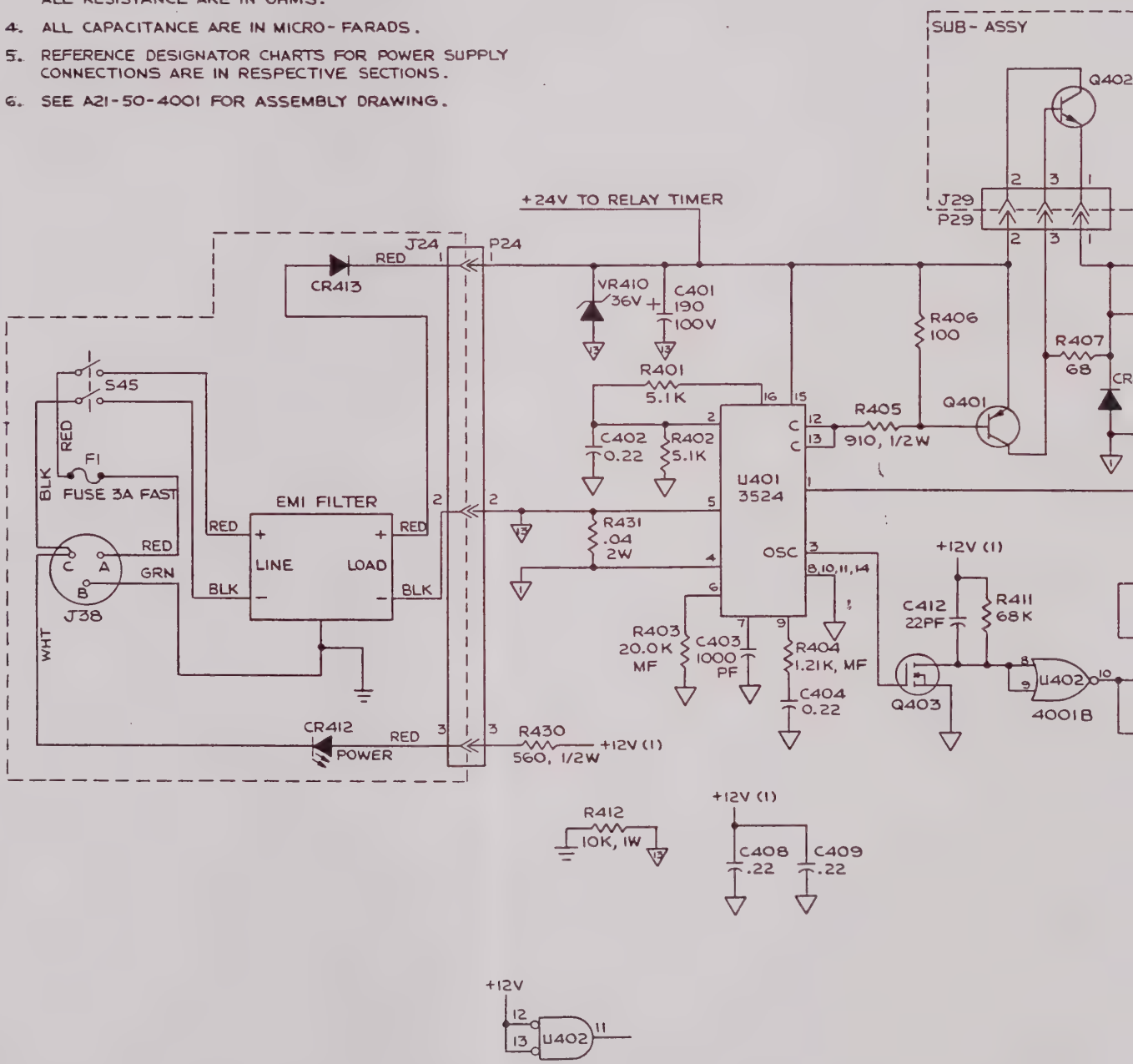
PART NO.	SIZE	DRAWING NO.
718403	D	A21-50-4001
SCALE 1:	SH 4 OF 4	REV B

PROPRIETARY

DIST

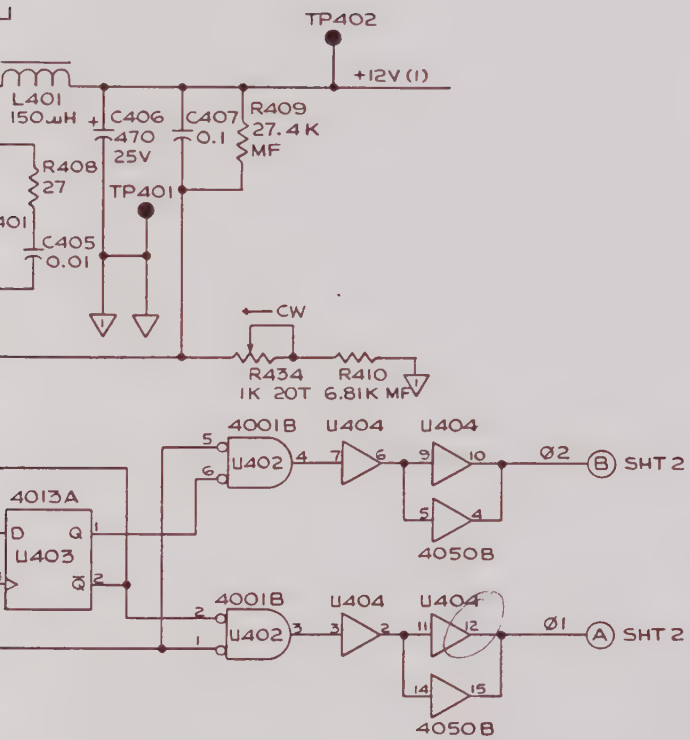
NOTES : UNLESS OTHERWISE SPECIFIED

1. SEE A21-50-1601 FOR REFERENCE DESIGNATION DRAWING.
2. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 & Y32.14.
3. ALL RESISTORS ARE 1/4W, 5%, CARBON FILM.
   ALL RESISTANCE ARE IN OHMS.
4. ALL CAPACITANCE ARE IN MICRO-FARADS.
5. REFERENCE DESIGNATOR CHARTS FOR POWER SUPPLY CONNECTIONS ARE IN RESPECTIVE SECTIONS.
6. SEE A21-50-4001 FOR ASSEMBLY DRAWING.



REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
D	REVISED PER DCO # 36792. REDRAWN SHT 1 WITH CHANGES. SEE SUPERSEDED SHT 1 FOR PRIOR REVISIONS. INCORP DCO 38514 INCORP DCO 38773. INCORP DCO 39519. INCORP DCO 39555.		VL 6/14/89 VL 8/11/89 VL 12/15/89 VL 4/11/90	AJC 5/17/90	AKW 5/18/90	6/23/90
E	DCO # 40996. C412 VALUE WAS 100 PF; R411 VALUE WAS 10K, SHT 1 ZN B-5.		VL 10/3/90			AJC 10/5/90
E1	DCO # 42233. J25 PINS "A B C D" WAS PINS "4 3 2 1", SHT 9, ZN B-3.		VL 3/12/91		AKW 3/20/91	AKW 3/20/91

A21-50-1001 REV E1 SH 1 OF 9



REF DES	+12V (1)	▽
U401		8, 10, 11, 14
U402	12, 13, 14	7
U403	9, 11, 14	4,6,7,8,10
U404	1	8

REFERENCE DESIGNATION		
FIRST USED	LAST USED	NOT USED
U401	U404	
R401	R434	R415, 416, 417, 420, 421, 422, R425, R429
Q401	Q419	Q409, 410, 414, 413, 417, 418
CR410	CR412	CR411
VR410		
C401	C418	C409, C418
L401	L401	
T1	T4	
S401	S404	
RT401	RT403	
TP401	TP402	
REFERENCE DESIGNATION FOR SWITCHES & CONNECTORS		
FIRST USED	LAST USED	NOT USED
S1	S46	S21, S28
P2	P29	P16
J2	J29	J16

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

BASIC		
DWG NO.	DRAWING NO.	PART NO.
SUFFIX	FIRST USED ON	
APPLICATION		

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DIMENSIONS IN INCHES
X_C =

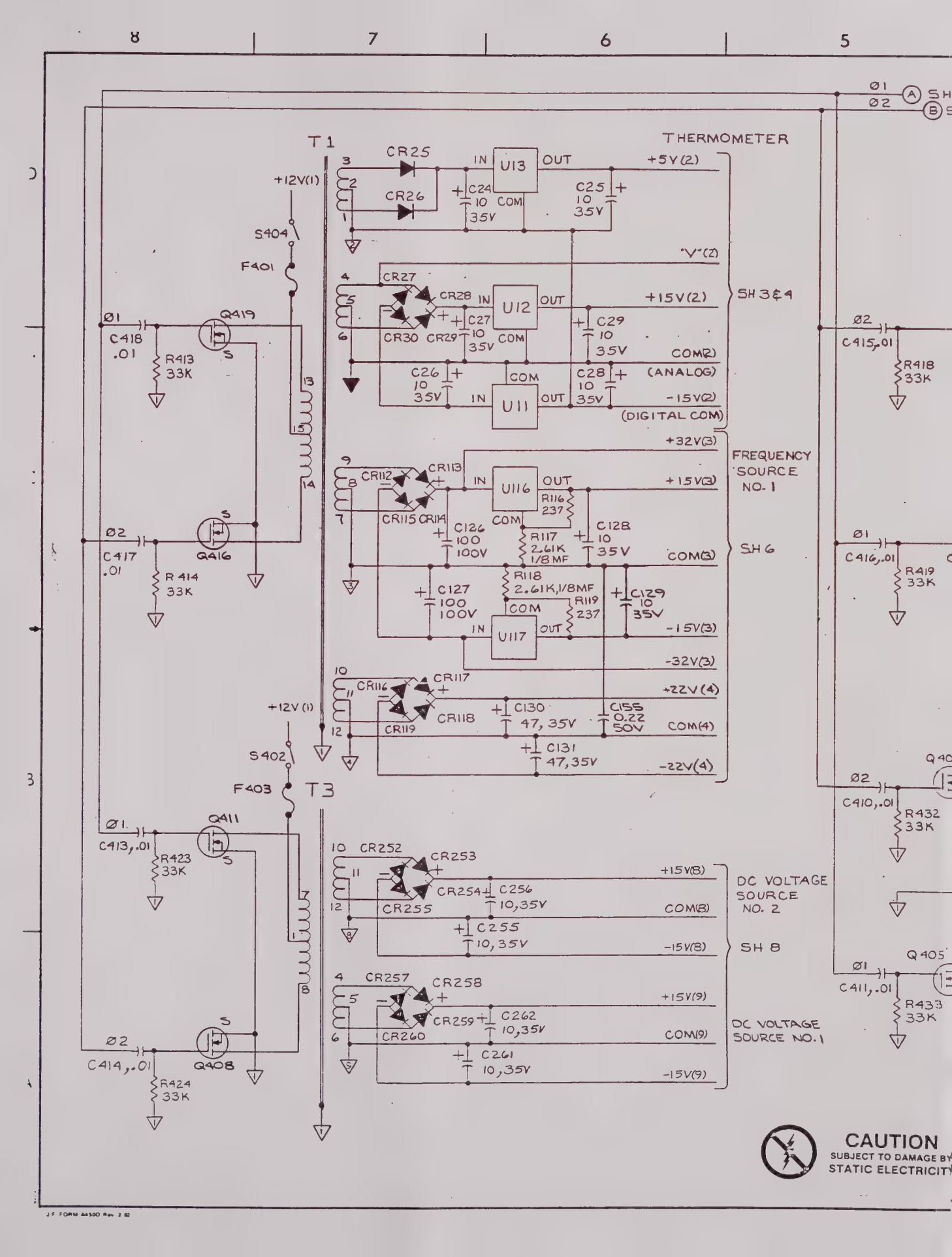
DWN	VIET LE	6/14/89
CHK	Ami Coberly	5/17/90
PROJ ENGR		
MFG ENGR		6/23/90
FINISH		

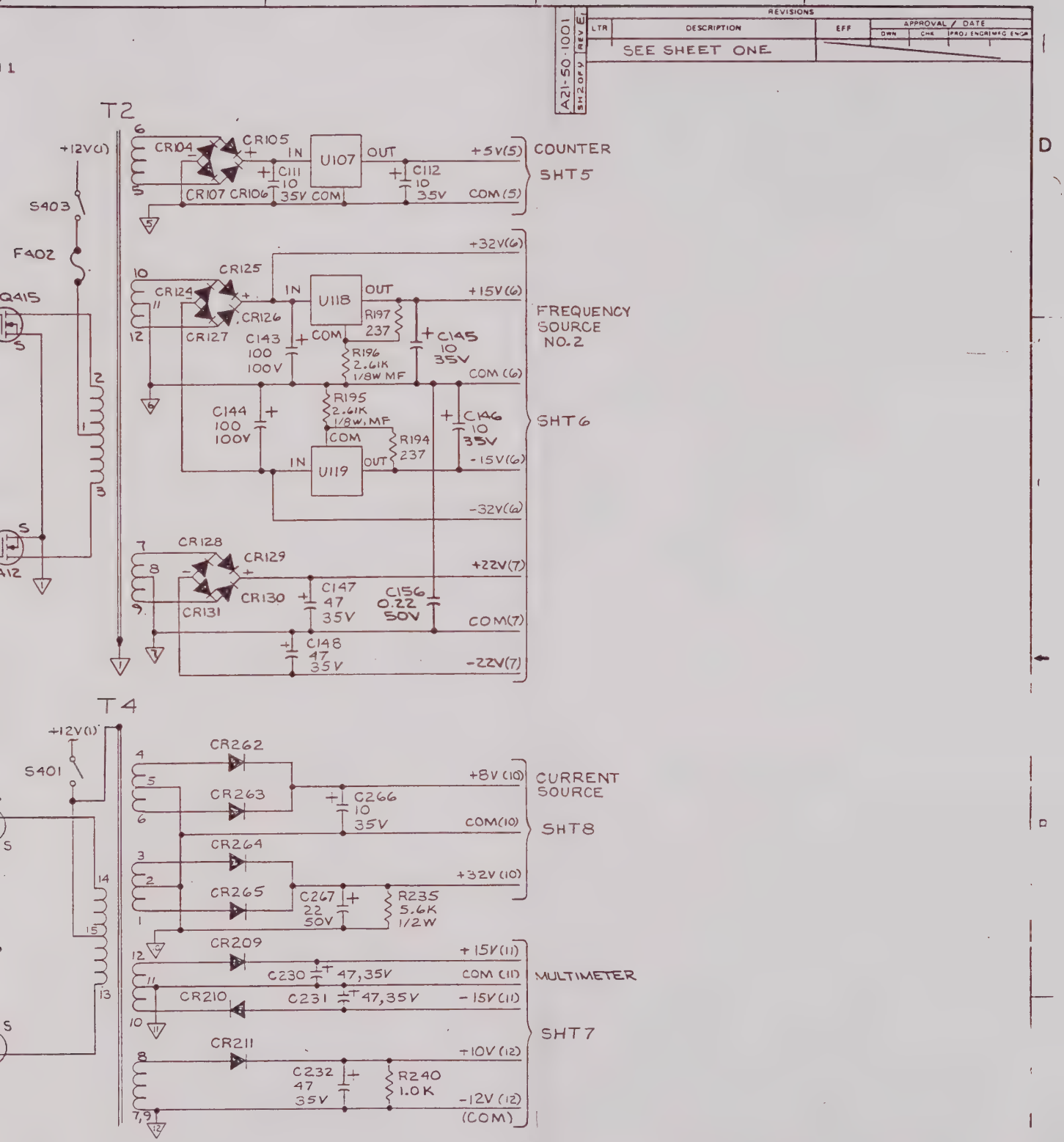
SCHEMATIC, MAIN
(PREREGULATOR)

PART NO.	SIZE	DRAWING NO
	D	A21-50-1001
SCALE ——	SH 1 OF 9	REV E1

PROPRIETARY

DIST


8
7
6
5
T1
THERMOMETER
CR25
CR26
U13
IN
OUT
+5V(2)
C24
10
35V
COM
C25
10
35V
+12V(1)
S404
F401
"V"(2)
CR27
CR28
CR29
CR30
U12
+15V(2)
C27
C29
C26
C28
COM(2)
(ANALOG)
U11
-15V(2)
(DIGITAL COM)
SH 3&4
Q419
C418
.01
R413
33K
Ø1
+32V(3)
CR112
CR113
CR114
CR115
U116
+15V(3)
R116
237
C126
100
100V
R117
2.61K
1/8MF
C128
COM(3)
SH 6
FREQUENCY
SOURCE
NO. 1
Q416
C417
.01
R414
33K
Ø2
R118
2.61K,1/8MF
C127
R119
237
C129
U117
-15V(3)
-32V(3)
CR116
CR117
CR118
CR119
+22V(4)
C130
47, 35V
C155
0.22
50V
COM(4)
C131
47,35V
-22V(4)
+12V(1)
S402
F403
T3
Q411
C413,.01
R423
33K
CR252
CR253
CR254
CR255
+15V(8)
C256
10,35V
COM(8)
C255
10,35V
-15V(8)
SH 8
DC VOLTAGE
SOURCE
NO. 2
CR257
CR258
CR259
CR260
+15V(9)
C262
10,35V
COM(9)
C261
10,35V
-15V(9)
DC VOLTAGE
SOURCE NO. 1
Q408
C414,.01
R424
33K
Ø2
Ø1
Ø2
A
B
SH
C415,.01
R418
33K
C416,.01
R419
33K
C410,.01
R432
33K
C411,.01
R433
33K
Q405
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY


4
3
2
1
REVISIONS
LTR
DESCRIPTION
EFF
APPROVAL / DATE
DWN
CHK
PROJ ENGR
MFG ENGR
SEE SHEET ONE
A21-50-1001
REV E1
SH 2 OF 9
T2
+12V(1)
S403
F402
Q415
CR104
CR105
CR107
CR106
IN
U107
OUT
COM
C111
10
35V
C112
10
35V
+5V(5)
COM(5)
COUNTER
SHT5
+32V(6)
CR125
CR124
CR126
CR127
U118
+15V(6)
R197
237
C143
100
100V
C145
10
35V
R196
2.61K
1/8W MF
COM(6)
R195
2.61K
1/8W, MF
C144
100
100V
C146
10
35V
R194
237
U119
-15V(6)
-32V(6)
FREQUENCY
SOURCE
NO.2
SHT6
CR128
CR129
CR130
CR131
C147
47
35V
C156
0.22
50V
+22V(7)
COM(7)
C148
47
35V
-22V(7)
T4
+12V(1)
S401
CR262
CR263
CR264
CR265
C266
10
35V
+8V(10)
COM(10)
+32V(10)
C267
22
50V
R235
5.6K
1/2W
CURRENT
SOURCE
SHT8
CR209
CR210
C230
47,35V
C231
47,35V
+15V(11)
COM(11)
-15V(11)
MULTIMETER
SHT7
CR211
C232
47
35V
R240
1.0K
+10V(12)
-12V(12)
(COM)
QTY
ITEM
PART NO.
DRAWING NO
DESCRIPTION
REF DES
PARTS LIST
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JOHN FLUKE MFG. CO., INC.
P.O. BOX C9090
EVERETT, WA 98206
89536
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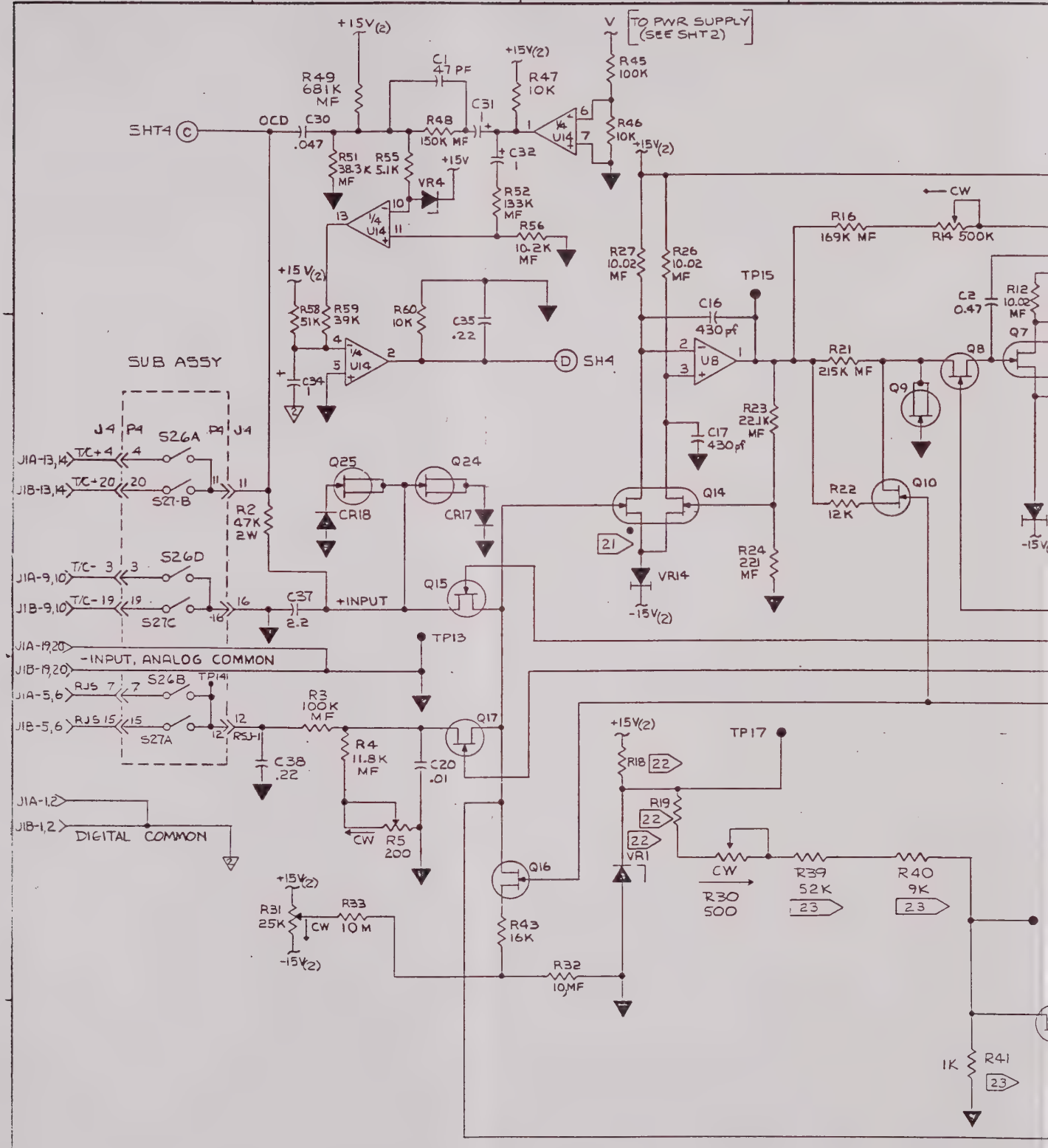
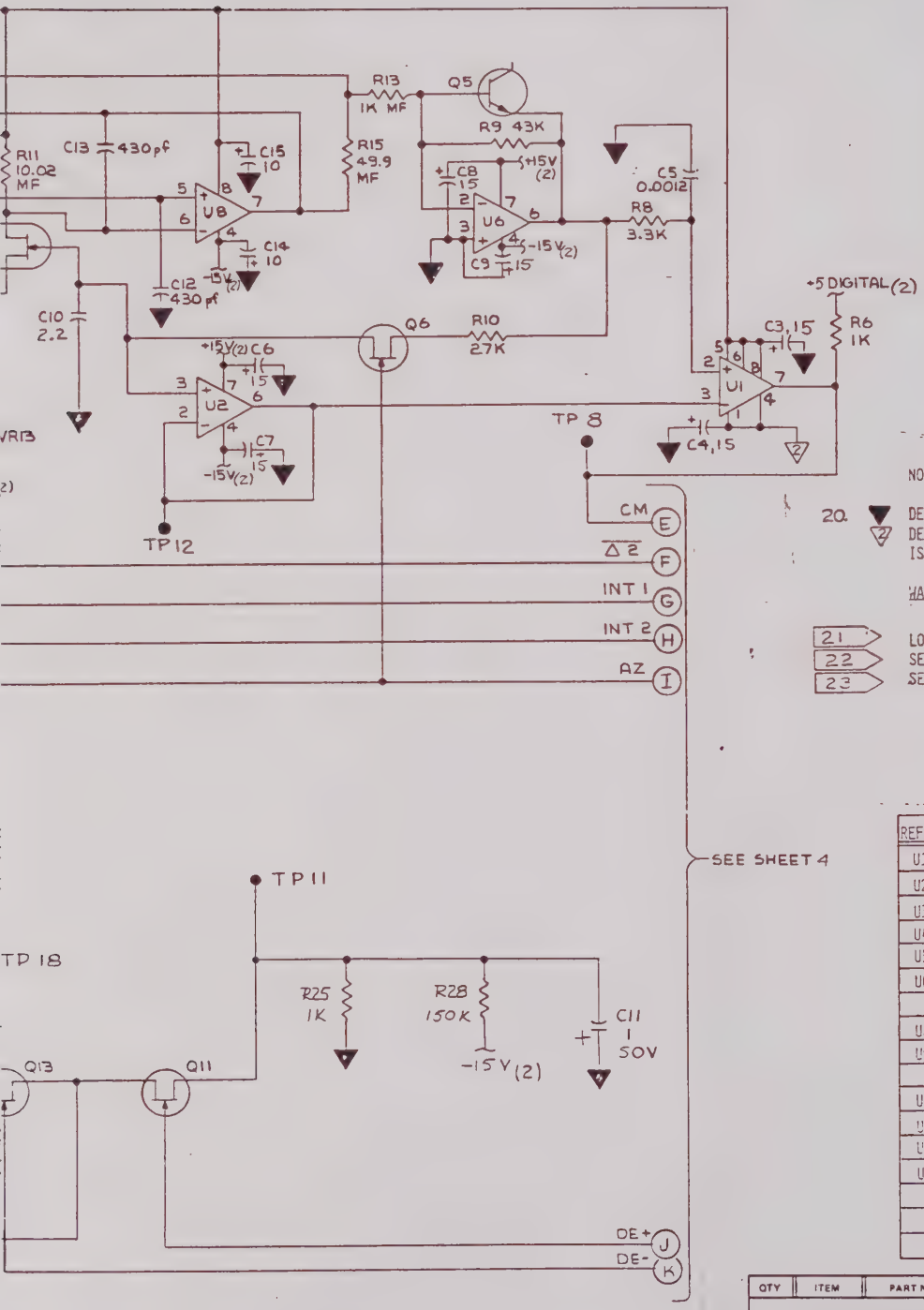
TOLERANCE
DIMENSIONS IN INCHES
FINISH
DWN B. HANSON 4-9-84
CHK A. Coberly 10-27-6
PROJ ENGR T.L. ROEF 5/11/84
MFG ENGR A.K. WEISS 7/31/84
SCHEMATIC, MAIN
(POWER SUPPLY)
PART NO.
SIZE
DRAWING NO
D
A21-50-1001
SCALE
SH 2 OF 9
REV E1
BASIC
OWG NO
SUFFIX
DRAWING NO
PART NO.
FIRST USED ON
APPLICATION
PROPRIETARY


8
7
6
5
+15V(2)
V
TO PWR SUPPLY (SEE SHT 2)
R45 100K
R46 10K
R47 10K
C1 47 PF
C31
R49 681K MF
SHT4
OCD
C30 .047
R48 150K MF
C32
R51 38.3K MF
R55 5.1K
+15V
VR4
R52 133K MF
R56 10.2K MF
U14
R27 10.02 MF
R26 10.02 MF
TP15
C16 430 pf
U8
R16 169K MF
R14 500K
CW
C2 0.47
R12 10.02 MF
Q7
Q8
R21 215K MF
Q9
R23 22.1K MF
C17 430 pf
R22 12K
Q10
R24 221 MF
Q14
VR14
-15V(2)
R58 51K
R59 39K
R60 10K
C35 .22
C34
SH4
SUB ASSY
J4
P4
S26A
S27-B
S26D
S27C
S26B
S27A
J1A-13,14
J1B-13,14
T/C+4
T/C+20
J1A-9,10
J1B-9,10
T/C- 3
T/C-19
R2 47K 2W
Q25
Q24
CR18
CR17
Q15
C37 2.2
+INPUT
J1A-19,20
J1B-19,20
-INPUT, ANALOG COMMON
TP13
J1A-5,6
J1B-5,6
RJS 7
RJS 15
TP14
R3 100K MF
Q17
R4 11.8K MF
C38 .22
C20 .01
R5 200
CW
J1A-1,2
J1B-1,2
DIGITAL COMMON
R18 22
R19 22
22
VR1
TP17
R30 500
R39 52K
R40 9K
23
Q16
R43 16K
R31 25K
R33 10 M
R32 10 MF
1K
R41
CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICIT

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHT 1 FOR REVS					

A21-50-1001 REV E1
SH 3 OF 9



REF DES CHART		
FIRST USED	LAST USED	NOT USED
U1	U21	U5, U7, U9, U10, U15 THRU U19
R2	R83	R7, R17, R20, R29, R34 THRU R38, R53, R54, R64 THRU R69, R72, R73, R74 R78
Q5	Q25	Q12, Q18 THRU Q22
CR15	CR30	CR19, CR21 THRU CR 24
VR1	VR75	VR2, VR3, VR5 THRU VR12, VR15 THRU VR18, VR20 THRU VR74
C1	C41	C18, C19, C21, C22, C33, C39
Z5	Z5	
TP1	TP19	TP13 TP15

NOTES: (CONT.)

20. ▼ DENOTES ANALOG COMMON (0 VOLTS), ▽2 DENOTES DIGITAL COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON.

WARNING: DO NOT CONNECT ▽2 TO ▼, DAMAGE MAY RESULT.

21 LOCATE WITH MARKED GATE IN POSITION SHOWN.
22 SELECTED SET.
23 SELECTED SET.

REF DES	+5 DIG (2)	+15V (2)	▽2 -15V (2)	▼
U1		5,6,8	1,4	
U2		7	4	
U3	14		7	
U4	40		20,21	
U5				1
U6		7	4	
U8		3	4	
U9				7,8
U11				
U12				
U13				
U14		3	12	5,7

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES
PARTS LIST					

BASIC		
DWG NO.	DRAWING NO	PART NO.
SUFFIX	FIRST USED ON	
APPLICATION		

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MOUNTLAKE TERRACE, WA 98043

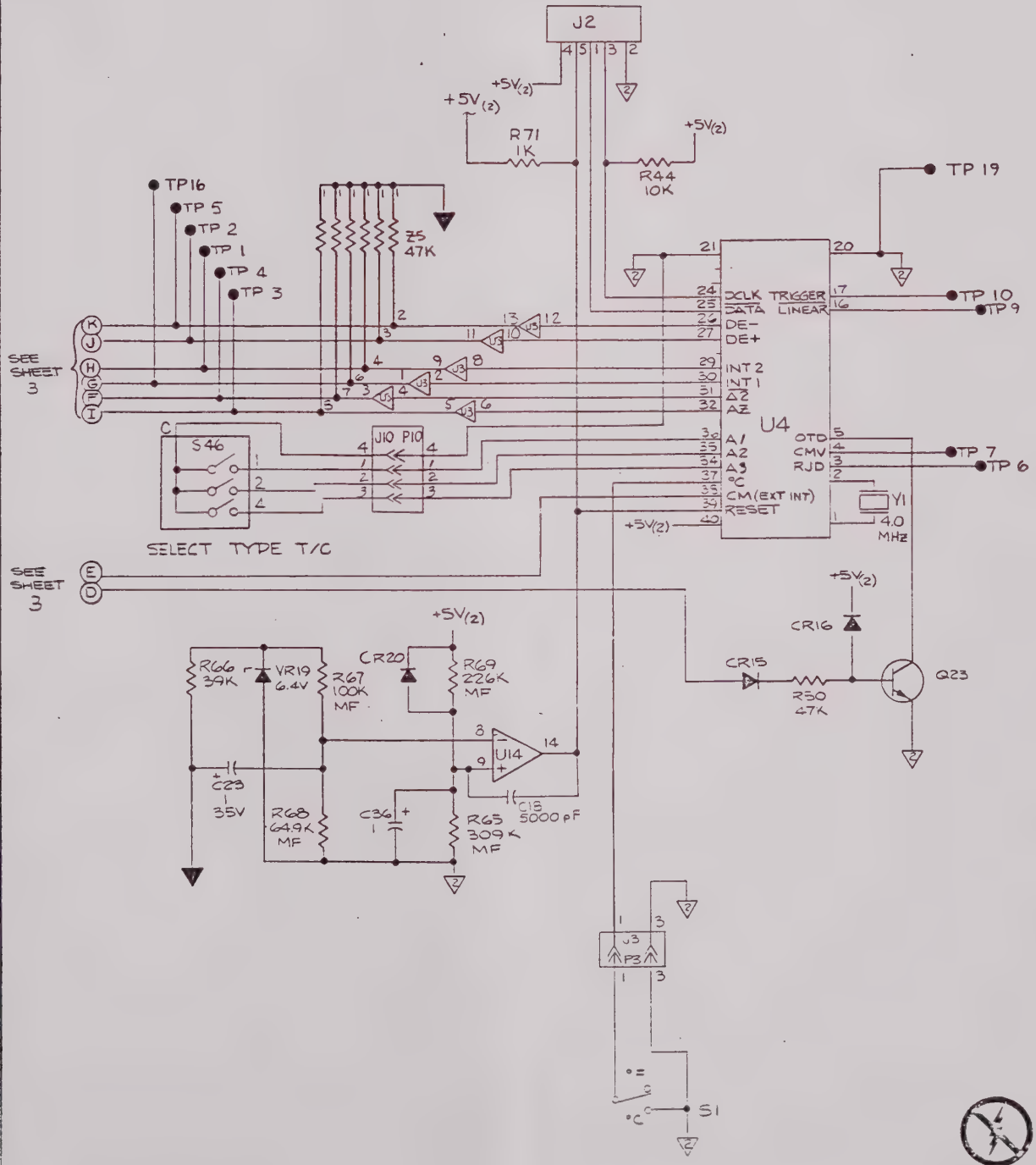
DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE: .XX = ± —, .XXX = ± —, ANGLES = ± —
DIMENSIONS IN INCHES: X_C = —
FINISH: —

DWN	L. Isaacson	2-15-80
CHK	MARK SMITH	2-14-80
PROJ ENGR	TL ROSE	9/1/84
MFG ENGR	M. A. WEIS	9/7/84

SCHEMATIC, MAIN
(THERMOMETER)

PART NO.	SIZE	DRAWING NO
—	D	A21-50-1001
SCALE —	SH 3 OF 9	REV E1



CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI

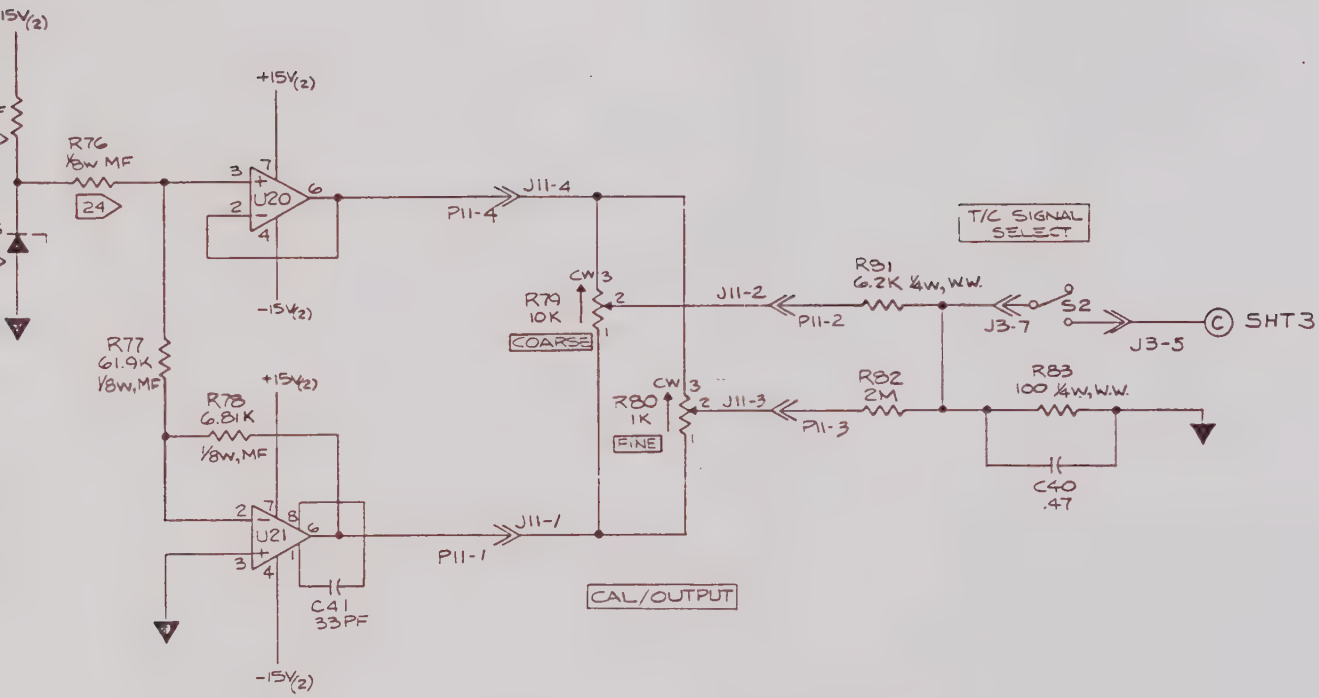
REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHT 1 FOR REVS

A21-50-1001 REV E1
SH 4 OF 9

NOTES: (CONT.)

24 SELECTED SET



QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

PARTS LIST

BASIC	—	—
DWG NO. SUFFIX	DRAWING NO. FIRST USED ON	PART NO.
APPLICATION		

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89536

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED

TOLERANCE: XX = ± —, XXX = ± —, ANGLES = ± —

DIMENSIONS IN INCHES

FINISH —

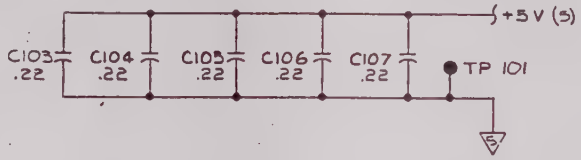
DWN	MARK SMITH	2-19-84
CHK	D.C. GARRETT	2-19-84
PROJ ENGR	T.L. ROOZ	9/1/-4
MFG ENGR	J.K. JOISS	7/31/84

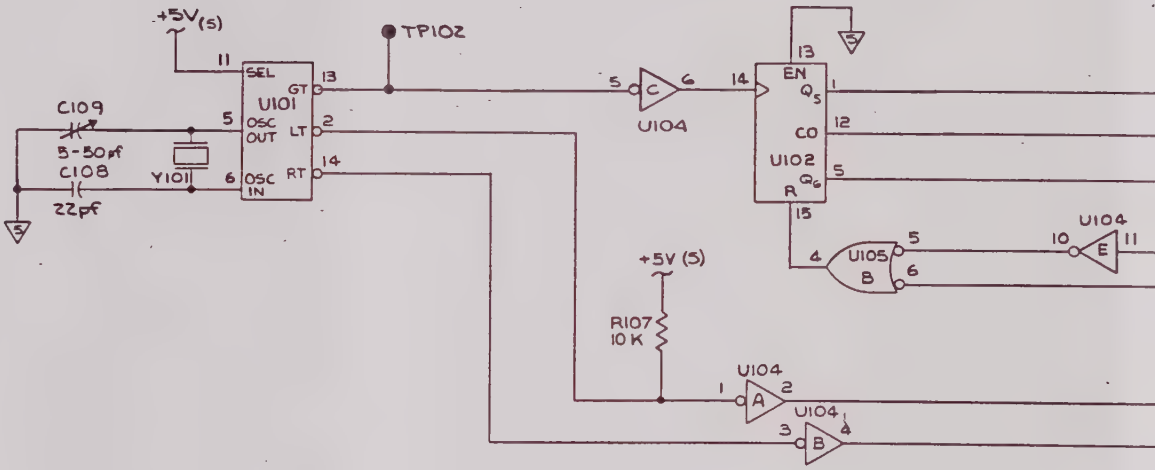
SCHEMATIC, MAIN
(THERMOMETER-CALIBRATOR)

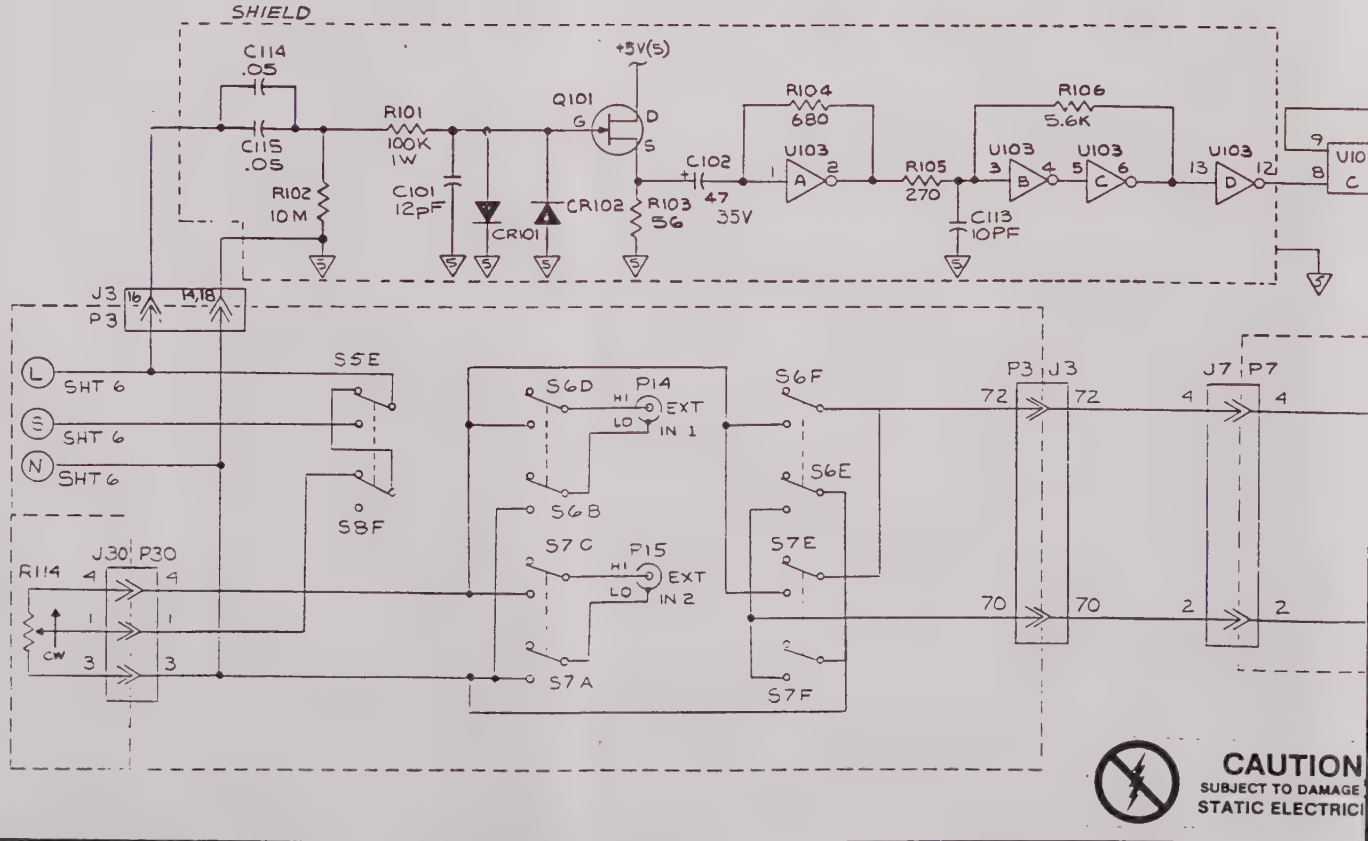
PART NO.	SIZE	DRAWING NO
—	D	A21-50-1001

SCALE — SH 4 OF 9 REV E1

DIGIT







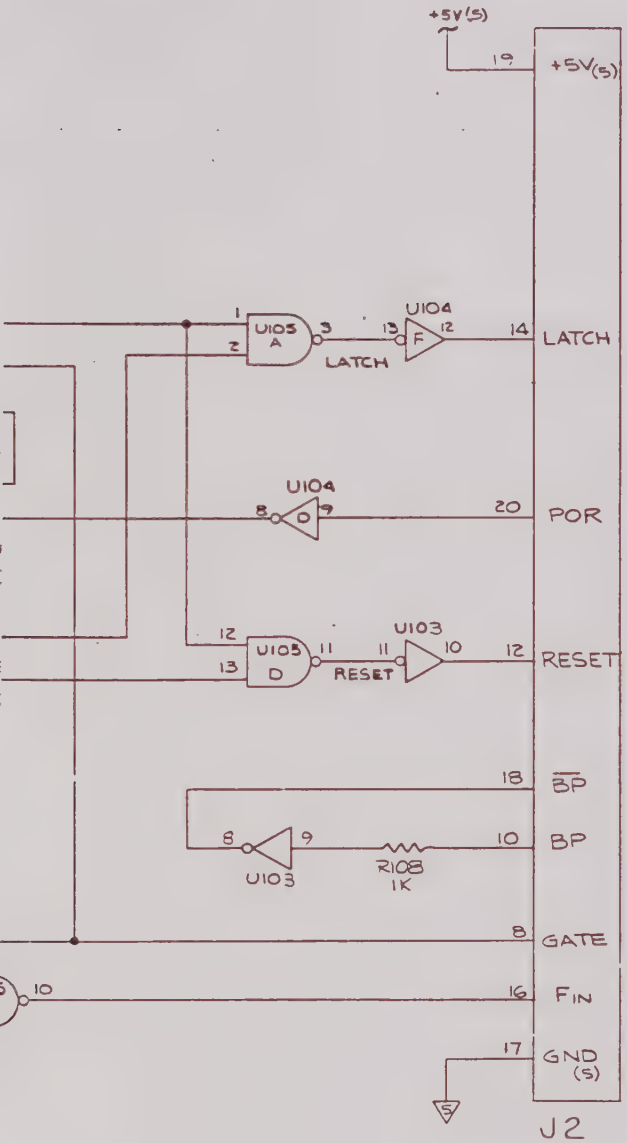
CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI

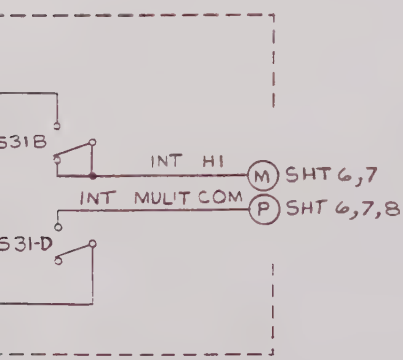
REVISIONS							
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHT 1 FOR REVS					

A21-50-1001 REV E SH 5 OF 5

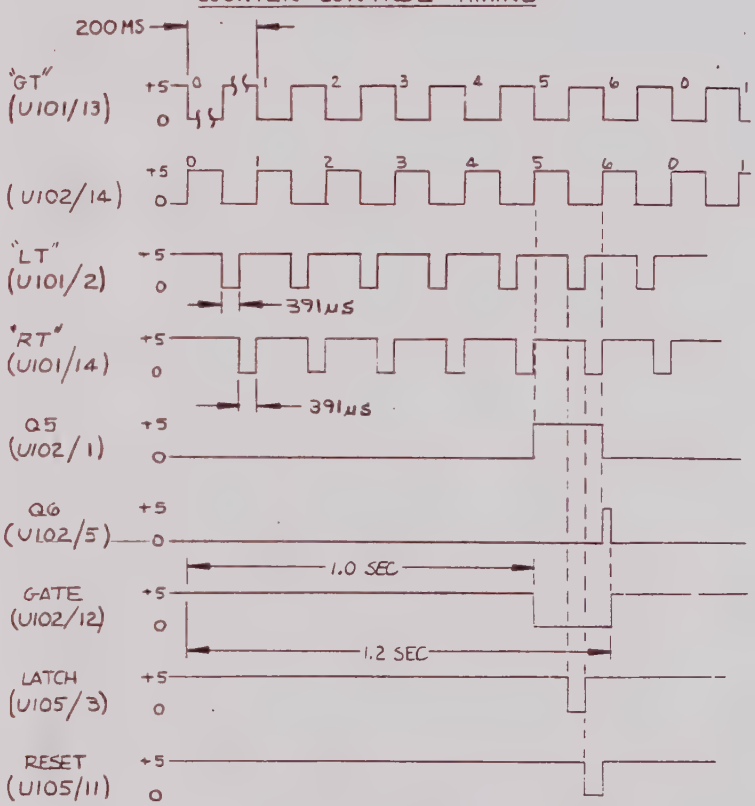
NOTES: UNLESS OTHERWISE SPECIFIED

(14) PIN NUMBERS SHOWN REFER TO CONNECTIONS BETWEEN A1-J4 AND A5-P4 (TYP)





COUNTER CONTROL TIMING



REF DES	+5V	GND
U101	10,11	4
U102	16	8,13
U103	14	7
U104	14	7
U105	14	7

REF DES CHART

FIRST USED	LAST USED	NOT USED
U101	U119	U106
R101	R197	R120, 121
Q101	Q109	
CR101	CR131	CR103
VR110	VR123	VR112 THRU VR121
C101	C158	
TP101	TP106	
L101	L102	

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

BASIC DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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TOLERANCE .X = ± .XX = ± .XXX = ± ANGLES = ±
DIMENSIONS IN INCHES X_C =
FINISH

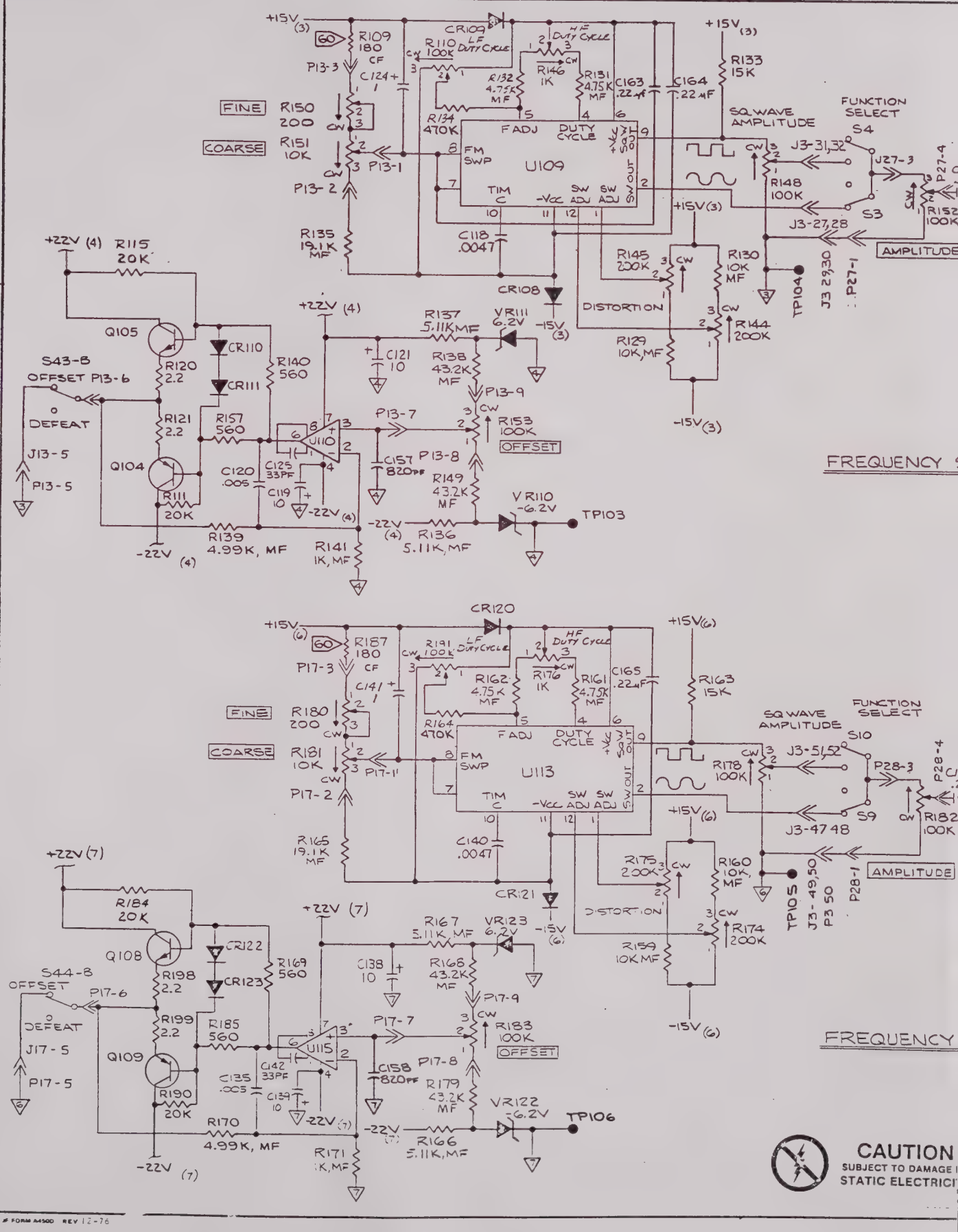
DWN	C. Isaacson H	11-18-81
CHK	D.C. BARRETT	8/14/82
PROJ ENGR	T.L. ROSE	8/1/84
MFG ENGR	J.R. WEISS	7/14/84

SCHEMATIC, MAIN (AUDIO FREQUENCY COUNTER)

PART NO.	SIZE	DRAWING NO
	D	A21-50-1001

SCALE — SH 5 OF 5 REV E

DIST


8
7
6
5
+15V (3)
R109 180 CF
CR109
R110 100K LF DUTY CYCLE
HF DUTY CYCLE
R146 1K
R131 4.75K MF
C163 .22 MF
C164 .22 MF
R133 15K
SQ WAVE AMPLITUDE
FUNCTION SELECT
S4
P13-3
C124 1
FINE
R150 200
COARSE
R151 10K
P13-1
P13-2
R132 4.75K MF
R134 470K
FADJ
DUTY CYCLE
U109
FM SWP
TIM C
SW ADJ
SW OUT
R148 100K
J3-31,32
J27-3
P27-4
S3
R152 100K
J3-27,28
AMPLITUDE
R135 19.1K MF
C118 .0047
+22V (4)
R115 20K
R145 200K
R130 10K MF
DISTORTION
R144 200K
R129 10K, MF
TP104
J3 29,30
P27-1
CR108
-15V (3)
Q105
CR110
CR111
R120 2.2
R140 560
S43-B
OFFSET P13-6
DEFEAT
R121 2.2
R157 560
J13-5
P13-5
Q104
C120 .005
C125 33PF
C119 10
R111 20K
U110
P13-7
P13-8
C157 820PF
R153 100K
OFFSET
R149 43.2K MF
VR110 -6.2V
TP103
R139 4.99K, MF
R141 1K, MF
-22V (4)
R137 5.11K MF
VR111 6.2V
C121 10
R138 43.2K MF
P13-9
R136 5.11K, MF
FREQUENCY
CR120
R187 180 CF
R191 100K LF DUTY CYCLE
HF Duty Cycle
R162 4.75K MF
R176 1K
R161 4.75K MF
C165 .22 MF
R163 15K
P17-3
C141 1
FINE
R180 200
COARSE
R181 10K
P17-1
P17-2
R164 470K
FADJ
DUTY CYCLE
U113
FM SWP
TIM C
SW ADJ
SW OUT
SQ WAVE AMPLITUDE
FUNCTION SELECT
S10
J3-51,52
P28-3
P28-4
R178 100K
S9
J3-47,48
R182 100K
AMPLITUDE
P28-1
J3-49,50
P3 50
TP105
R165 19.1K MF
C140 .0047
+22V (7)
R184 20K
CR121
R175 200K
R160 10K, MF
DISTORTION
R174 200K
R159 10K MF
R167 5.11K, MF
VR123 6.2V
C138 10
R168 43.2K MF
P17-9
Q108
CR122
CR123
R169 560
S44-B
OFFSET
P17-6
DEFEAT
R198 2.2
R199 2.2
R185 560
J17-5
P17-5
Q109
C135 .005
C142 33PF
C139 10
R190 20K
U115
P17-7
P17-8
C158 820PF
R183 100K
OFFSET
R179 43.2K MF
VR122 -6.2V
TP106
R170 4.99K, MF
R171 1K, MF
R166 5.11K, MF
-22V (7)
FREQUENCY
CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI
FORM A4500 REV 12-76

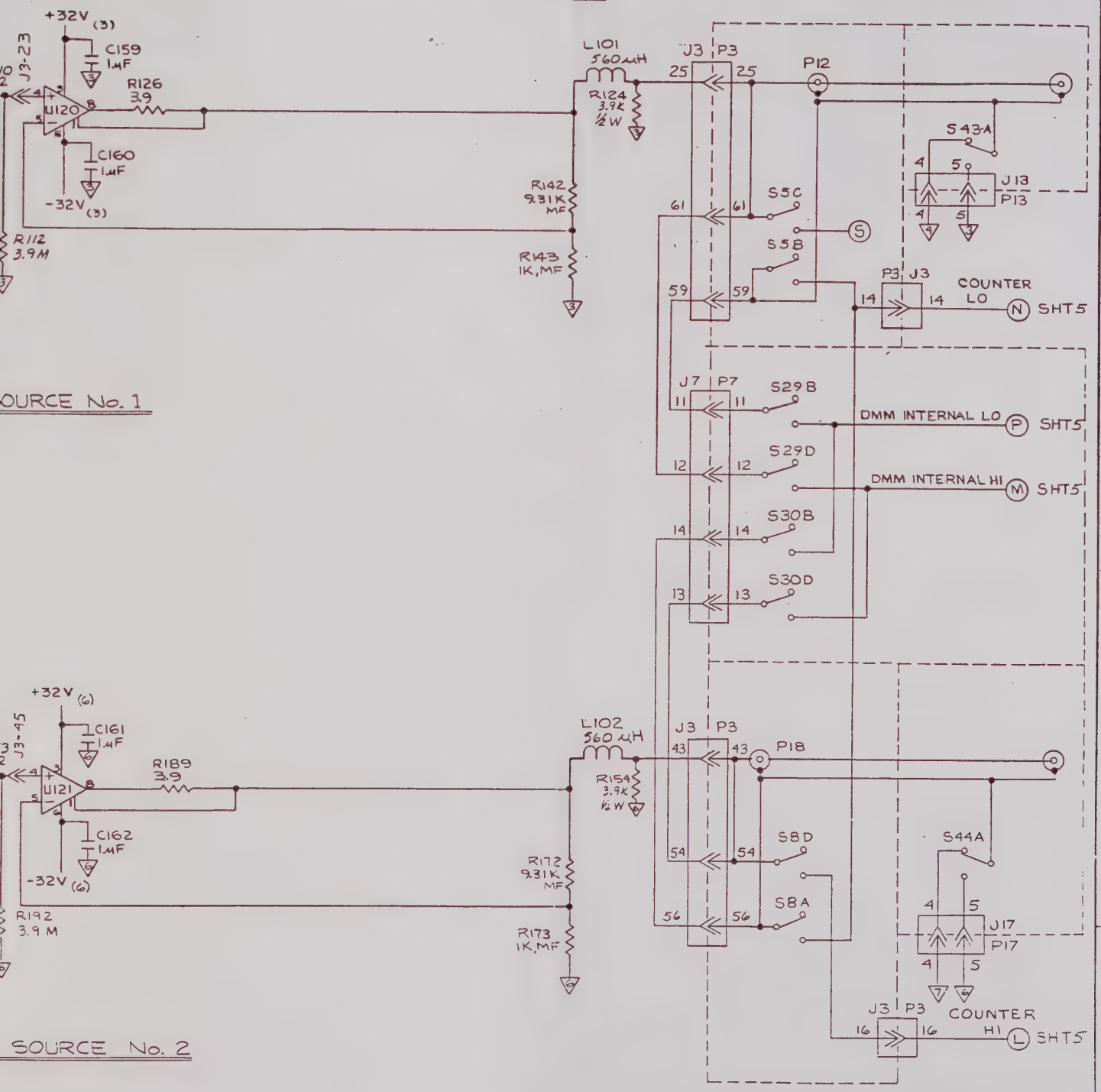
NOTES: (CONT.)

(60) 261 OR 220 OHMS PERMISSIBLE; 180 OHMS PREFERRED FOR LOW FREQ RANGE.

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
	SEE SHT 1 FOR REVS					

A21-50-1001 REV E1 SH 6 OF 9



QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REFDES

PARTS LIST

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89536 DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE
DIMENSIONS IN INCHES

DWN	MARK SMITH	3/8/84
CHK	D.C. SARRET	3/14/84
PROJ ENGR	T.L. ROBB	3/19/84
MFG ENGR	J.E. WEISS	7/2/84

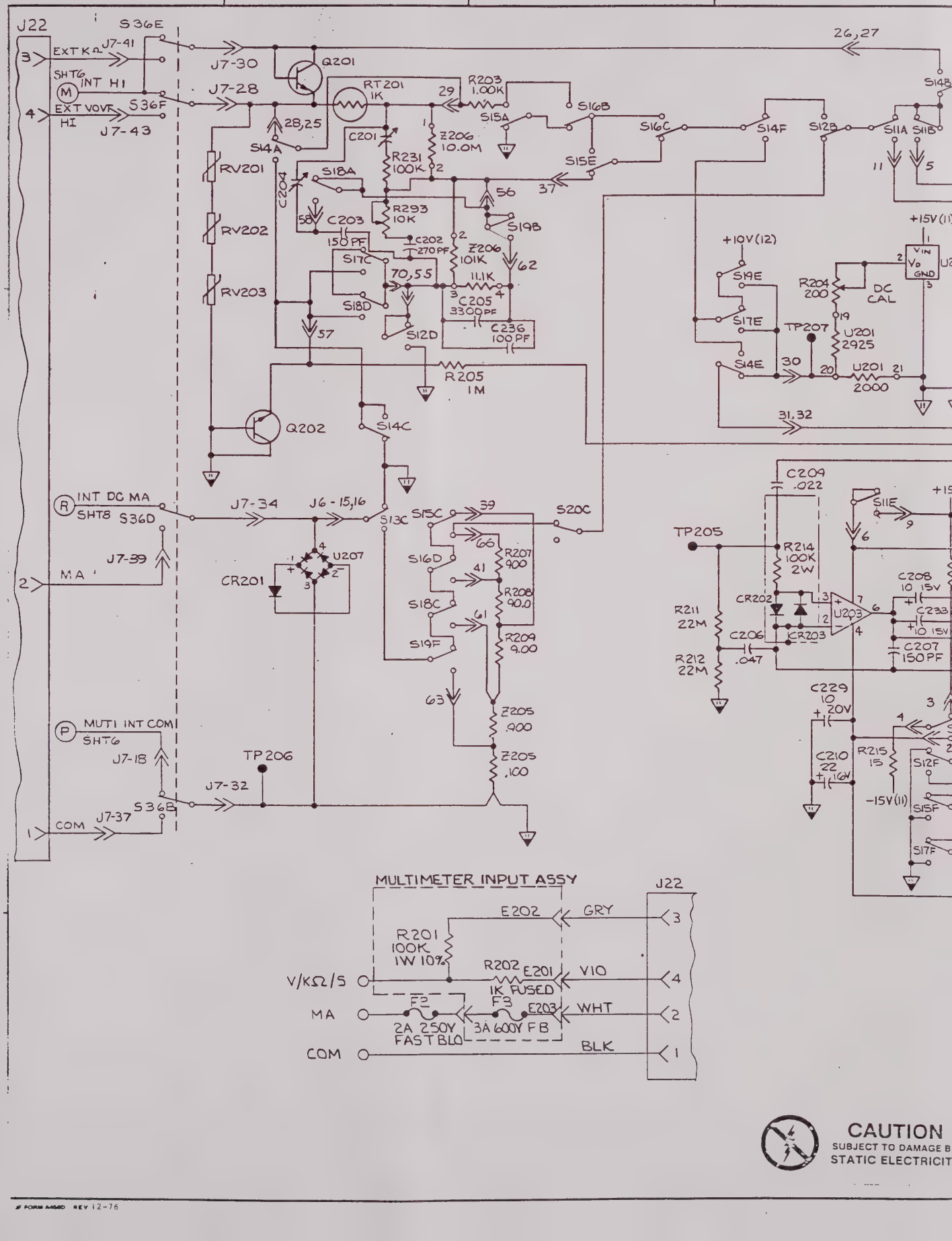
FINISH

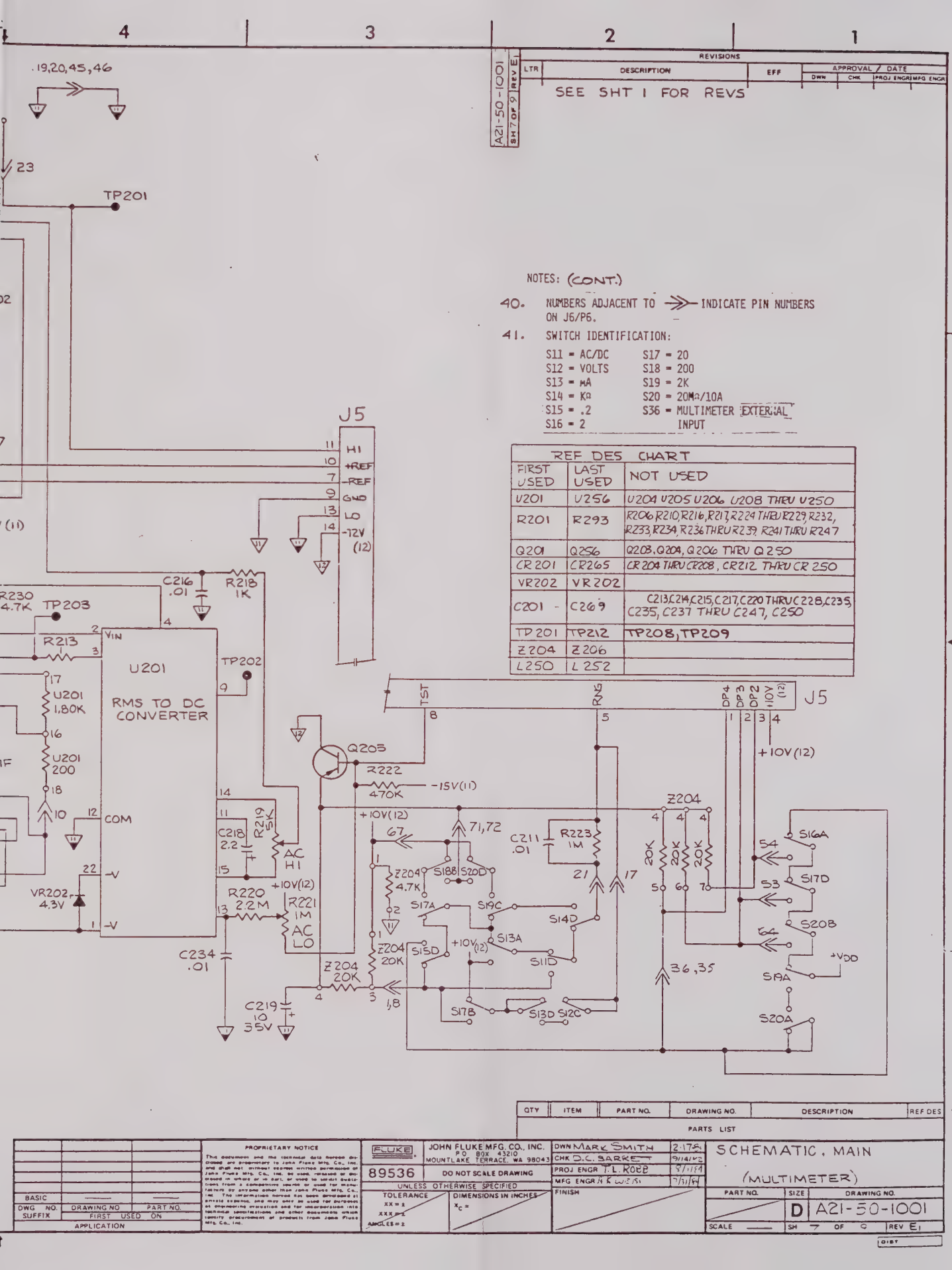
SCHEMATIC, MAIN
(FREQ. SOURCE 1 & 2)

BASIC		
DWG NO. SUFFIX	DRAWING NO FIRST USED ON	PART NO.
APPLICATION		

PART NO.	SIZE	DRAWING NO
	D	A21-50-1001
SCALE	SH 6 OF 9	REV E1

DIST


8
7
6
5
J22
S36E
EXT KΩ
J7-41
J7-30
Q201
SHT6
INT HI
J7-28
RT201
1K
R203
1.00K
S15A
S16B
S16C
S14F
S12B
S11A
S11B
S14B
EXT VOVR
HI
S36F
J7-43
28,25
S14A
C201
Z206
10.0M
R231
100K
S15E
RV201
RV202
RV203
C204
S18A
R293
10K
C203
150 PF
C202
270PF
Z206
101K
S19B
S17C
70,55
11.1K
C205
3300PF
S18D
S12D
C236
100 PF
R205
1M
Q202
S14C
+10V(12)
S19E
S17E
S14E
R204
200
DC
CAL
TP207
U201
2925
U201
2000
+15V(11)
VIN
Vo
GND
26,27
31,32
INT DC MA
SHT8 S36D
J7-34
J6-15,16
S13C
S15C
S20C
J7-39
MA
U207
CR201
R207
900
R208
90.0
R209
9.00
S16D
S18C
S19F
Z205
.900
Z205
.100
C209
.022
TP205
R214
100K
2W
R211
22M
R212
22M
CR202
CR203
U203
C206
.047
C208
10 15V
C233
10 15V
C207
150PF
C229
10
20V
C210
22
16V
R215
15
-15V(11)
S11E
S12F
S15F
S17F
MUTI INT COM
SHT6
J7-18
TP206
J7-32
S36B
J7-37
COM
MULTIMETER INPUT ASSY
J22
E202
GRY
R201
100K
1W 10%
R202
E201
VIO
1K FUSED
V/KΩ/S
F2
F3
E203
WHT
MA
2A 250V
FAST BLO
3A 600V FB
BLK
COM
CAUTION
SUBJECT TO DAMAGE B
STATIC ELECTRICIT


4
3
2
1
REVISIONS
LTR
DESCRIPTION
EFF
APPROVAL / DATE
DWN
CHK
PROJ ENGR
MFG ENGR
SEE SHT 1 FOR REVS
A21-50-1001
SH 7 OF 9
REV E1
19,20,45,46
23
TP201
J5
HI
+REF
-REF
GND
LO
-12V (12)
C216 .01
R218 1K
R230 4.7K
TP203
R213
U201
RMS TO DC CONVERTER
U201 1.80K
U201 200
TP202
COM
-V
VR202 4.3V
C218 2.2
R219 5K
AC HI
R220 2.2M
R221 1M
AC LO
C234 .01
C219 10 35V
Q203
R222 470K
-15V(11)
+10V(12)
TST
RNG
DP4
DP3
DP2
10V (12)
J5
+10V(12)
C211 .01
R223 1M
Z204
20K
S16A
S17D
S20B
+VDD
S19A
S20A
S18B
S20D
S17A
S19C
S14D
S13A
S11D
S15D
S17B
S13D
S12C
Z204 4.7K
Z204 20K
Z204 20K
36,35
71,72
67
1,8
NOTES: (CONT.)
40. NUMBERS ADJACENT TO ≫ INDICATE PIN NUMBERS ON J6/P6.
41. SWITCH IDENTIFICATION:
S11 = AC/DC
S12 = VOLTS
S13 = mA
S14 = KΩ
S15 = .2
S16 = 2
S17 = 20
S18 = 200
S19 = 2K
S20 = 20MΩ/10A
S36 = MULTIMETER EXTERNAL INPUT
REF DES CHART
FIRST USED
LAST USED
NOT USED
U201 U256 U204 U205 U206 U208 THRU U250
R201 R293 R206 R210 R216 R217 R224 THRU R229 R232, R233 R234 R236 THRU R239 R241 THRU R247
Q201 Q256 Q203, Q204, Q206 THRU Q250
CR201 CR265 CR204 THRU CR208, CR212 THRU CR250
VR202 VR202
C201 - C269 C213 C214 C215 C217 C220 THRU C228 C235 C235, C237 THRU C247, C250
TP201 TP212 TP208, TP209
Z204 Z206
L250 L252
QTY
ITEM
PART NO.
DRAWING NO.
DESCRIPTION
REF DES
PARTS LIST
PROPRIETARY NOTICE
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MOUNTLAKE TERRACE, WA 98043
89536
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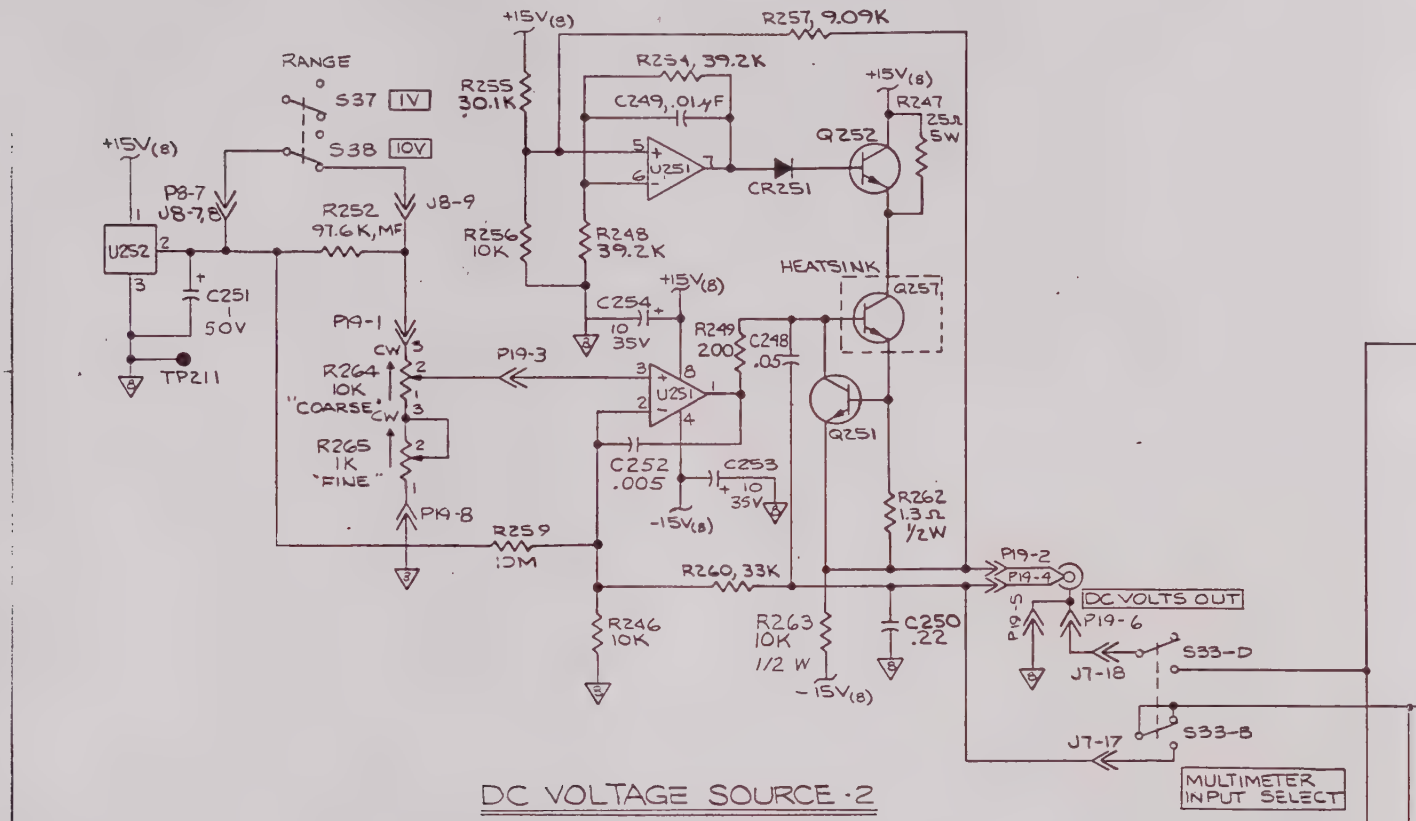
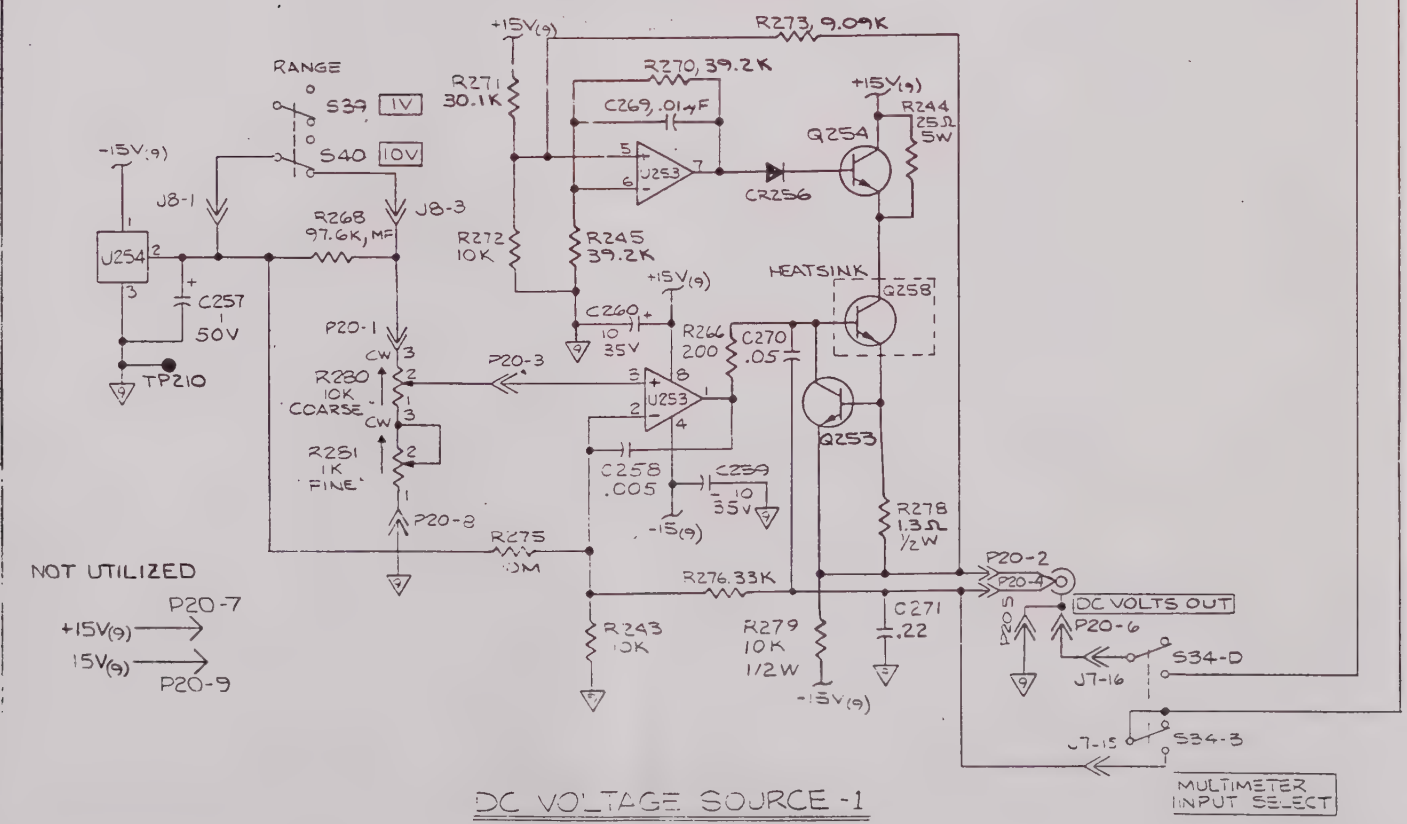
TOLERANCE
DIMENSIONS IN INCHES
FINISH
DWN MARK SMITH 2-17-84
CHK D.C. SARRE 9/14/84
PROJ ENGR T.L. ROEB 8/1/84
MFG ENGR R WILSON 7/31/84
SCHEMATIC, MAIN
(MULTIMETER)
PART NO.
SIZE
D
DRAWING NO.
A21-50-1001
SCALE
SH 7 OF 9
REV E1
BASIC
DWG NO.
SUFFIX
DRAWING NO
PART NO.
FIRST USED ON
APPLICATION



DC VOLTAGE SOURCE -2



DC VOLTAGE SOURCE -1

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE: DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHT 1 FOR REVS

A21-50-1001 SH 8 OF 9 REV E

MUTI INT COM (P) SHT 5
INT DC MA (R) SHT 7

S35B
S35D
MULTIMETER INPUT SELECT

J7-19
P7-20
J7-20,21
+32V (10)
L252 100μH
HI
P21-3,4
P21-5
LO

+8V(10)
U255
C264 1 50V
R287 18.2K MF
R286 511K MF
P21-2
TP212
R289 10K COARSE
CW
P21-1
R290 1K FINE
P21-6
R288 100K MF
+8V(10)
C265 10 35V
U256
R285 51.1K, MF
C263 .05
R284 51.1K, MF
J8-17
Q255
Q256
J8-19
J8-15

S41 1MA
S42 100MA
R282 1K, MF ½W
R283 10, MF ½W
P8-13
J8-13,14

CURRENT SOURCE

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

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FLUKE
JOHN FLUKE MFG. CO., INC.
P.O. BOX 43210
MOUNTLAKE TERRACE WA 98043

89536 DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE
DIMENSIONS IN INCHES
FINISH

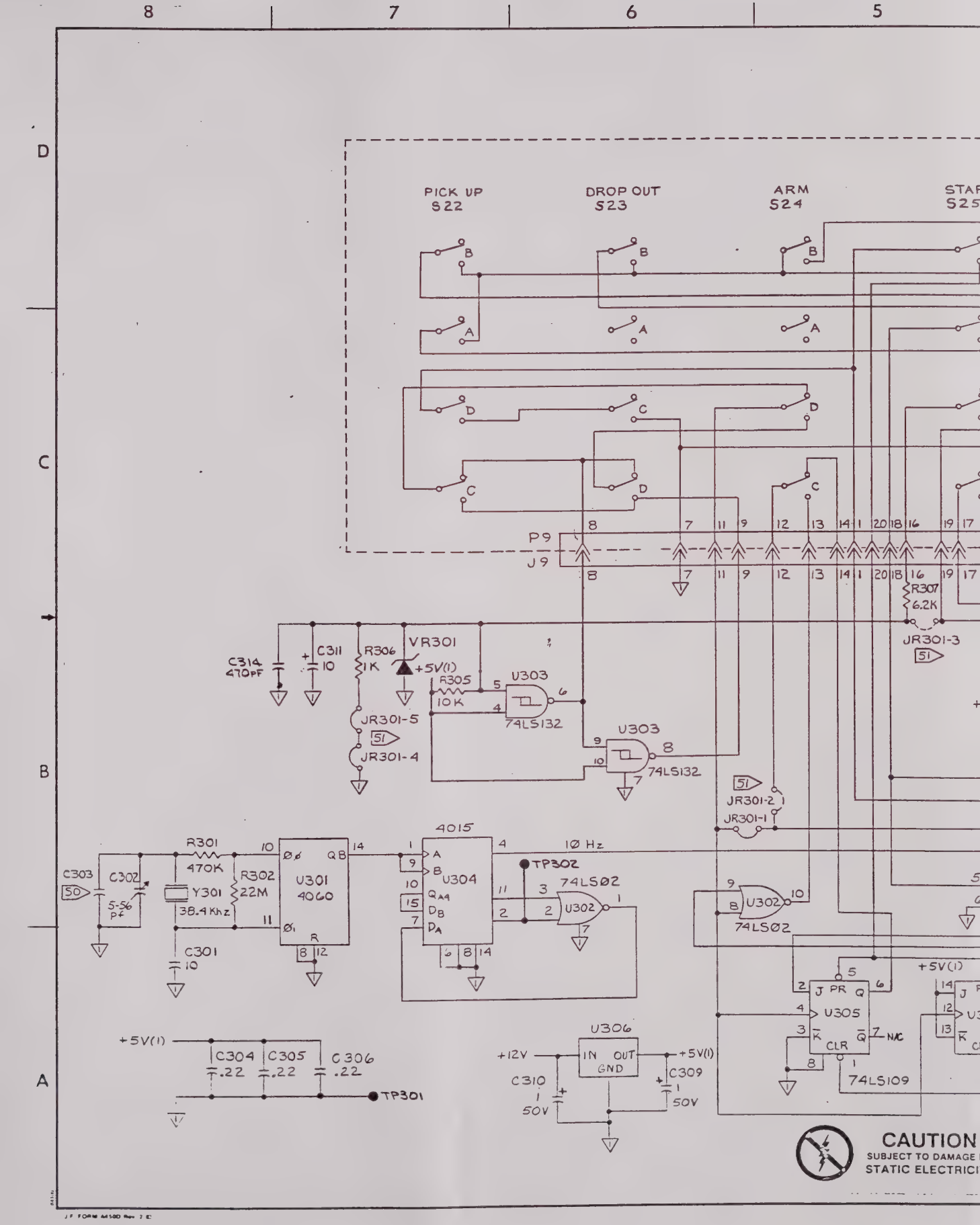
DWN	MARK SMITH 8-3-84
CHK	D.C. HARRETT 9/14/84
PROJ ENGR	T.L. ROBB 9/14/84
MFG ENGR	A.K. WATTS 9/5/84

SCHEMATIC, MAIN
(VOLTAGE & CURRENT SOURCES)

BASIC		
DWG NO	DRAWING NO	PART NO.
SUFFIX	FIRST USED ON	
APPLICATION		

PART NO.	SIZE	DRAWING NO
—	D	A21-50-1001
SCALE —	SH 9 OF 9	REV E1

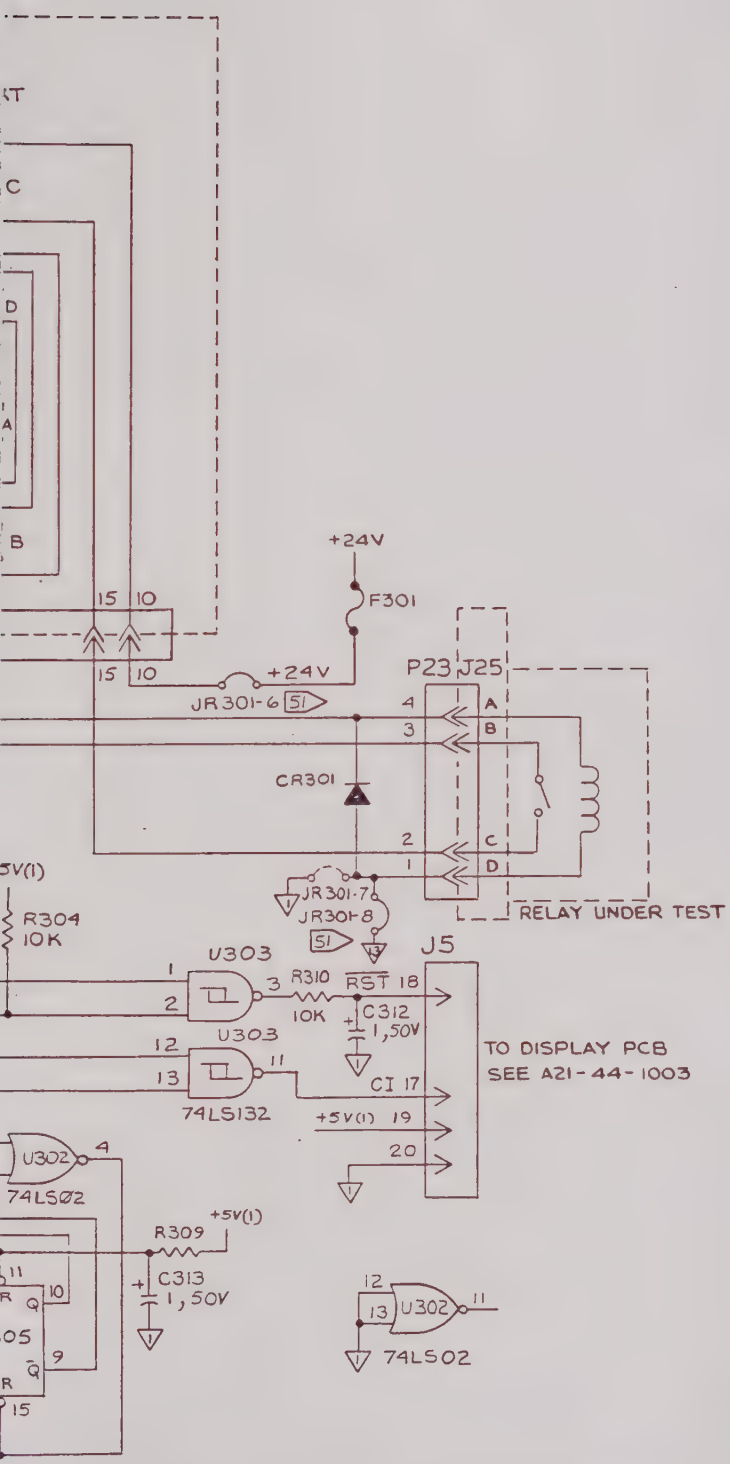
1 DIST


8
7
6
5
D
C
B
A
PICK UP
S22
DROP OUT
S23
ARM
S24
STAR
S25
P9
J9
R307
6.2K
JR301-3
51
C314
470PF
C311
10
R306
1K
VR301
+5V(1)
R305
10K
U303
74LS132
JR301-5
JR301-4
JR301-2
JR301-1
R301
470K
R302
22M
C303
50
C302
5-56 PF
Y301
38.4 Khz
C301
10
U301
4060
4015
U304
10 Hz
TP302
74LS02
U302
U305
74LS109
U306
+12V
IN
OUT
GND
C309
C310
50V
C304
.22
C305
.22
C306
.22
TP301
CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR/MFG ENGR
	SEE SHEETONE				

A21-50-1001 SH 9 OF 9 REV E1



NOTES: (CONTINUED)

50 SELECTED PART

51 TIMER CONFIGURATION IS DETERMINED IN THE FACTORY AT ASSEMBLY. THE RELAY TIMER REQUIRES POSITIONS 1,4,5,8 OF JR301 TO BE SHORTED AND POSITIONS 2,3, & 7 TO BE OPENED.

REF DES	+ 5V	▽
U301	16	8,12
U302	14	6,7,12,13
U303	14,4,10	7
U304	16	6,8,14
U305	13,14,16	3,8

REFERENCE DESIGNATION		
FIRST USED	LAST USED	NOT USED
C301	C311	
R301	R309	308, 303
CR301	CR301	
U301	U305	
Y301	Y301	
VR301	VR301	
	F301	

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

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FLUKE 89536

JOHN FLUKE MFG. CO., INC.
P.O. BOX C9090
EVERETT WA 98206

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE
DIMENSIONS IN INCHES
FINISH

DWN	R. HANSON	10-5-84
CHK	A. Coberly	10-27-84
PROJ ENGR	T. L. Roee	12/11/84
MFG ENGR	R. E. Weiss	12/31/84

SCHEMATIC, MAIN
(RELAY TIMER)

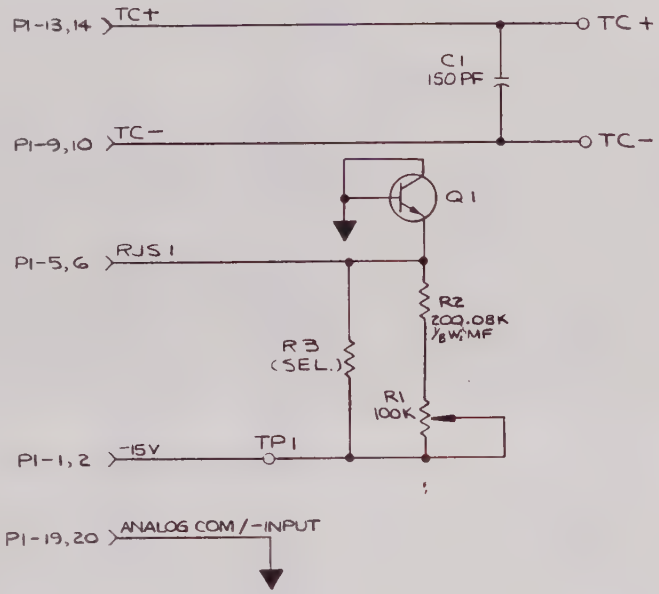
PART NO.	SIZE	DRAWING NO
	D	A21-50-1001

SCALE SH 5 OF 5 REV E1

BASIC
DWG NO SUFFIX | DRAWING NO | PART NO.
APPLICATION | FIRST USED ON

PROPRIETARY

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENG
A	C1 WAS 100pF. R2 WAS 150K.		DCB 9/14/82	DCB 9/14/82		
–	RELEASE TO PRODUCTION		DCB 4/24/84	[illegible] 7/31/84	[illegible] 6/26/84	DCB 6/26/84
B	DCO#25263 R1 WAS 50K		DCB 4/9/86		[illegible] 6/13/86	DCB 6/13/86



NOTES: UNLESS OTHERWISE SPECIFIED

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICRO-FARADS.
2. ALL RESISTORS ARE IN 1/4W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4. ▼ DENOTES ANALOG COMMON.
5. FOR ASSY DWG SEE A21-44-4002

A21-44-1002
SH 1 OF 1 REV B

QTY	ITEM	PART NO	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

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BASIC		
DWG NO SUFFIX	DRAWING NO.	PART NO.
APPLICATION	FIRST USED ON	

FLUKE
JOHN FLUKE MFG CO., INC.
P.O. BOX 43210
MOUNTLAKE TERRACE WA 98043

89536 DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE: XX = ± XXX = ± ANGLES = ±
DIMENSIONS IN INCHES: X_C =
FINISH

DWN	K. FUNG LAU	9/22/81
CHK	MARC SMITH	11/30/81
PROJ ENGR	T. KOBB	6/26/84
MFG ENGR	[illegible]	[illegible]

SCHEMATIC, THERMOCOUPLE INPUT

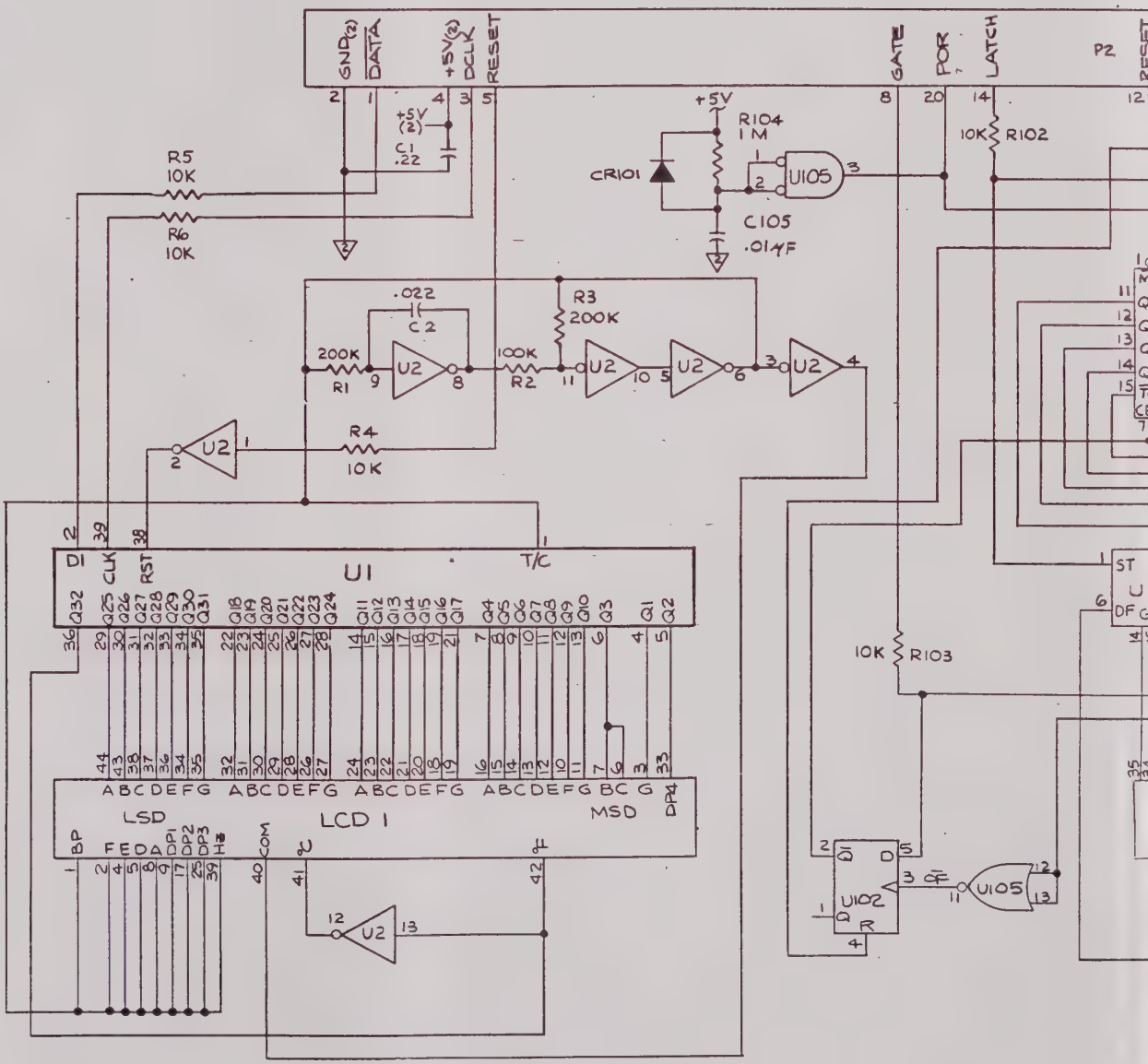
PART NO.	SIZE	DRAWING NO
—	C	A21-44-1002
SCALE —	SH 1 OF 1	REV B

DIST

FORM A450C REV : –

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
2. ALL RESISTORS ARE 1/4W, 5%, DEPOSITED CARBON. ALL RESISTANCE IS IN OHMS.
3. ALL CAPACITANCES ARE IN MICRO-FARADS.
4. SEE A21-44-4003 FOR ASSEMBLY DRAWING.



THERMOMETER

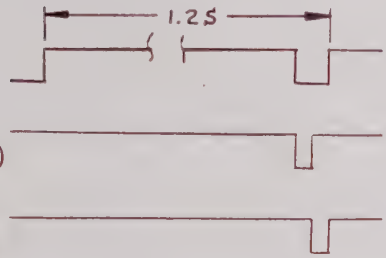
CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

4 3 2 1

REVISIONS					
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR / MFG ENGR
A	REVISED & REDRAWN		MJS 7-21-81		
B	EXTENSIVE REVISION		JJG 8-20-82	DCB 8/20/82	
1	RELEASE TO PRODUCTION		DCB 4/26/84	AJC 5/17/84	6/26/84 / 6/26/84

A21-44-1003 REV B SH 1 OF 2

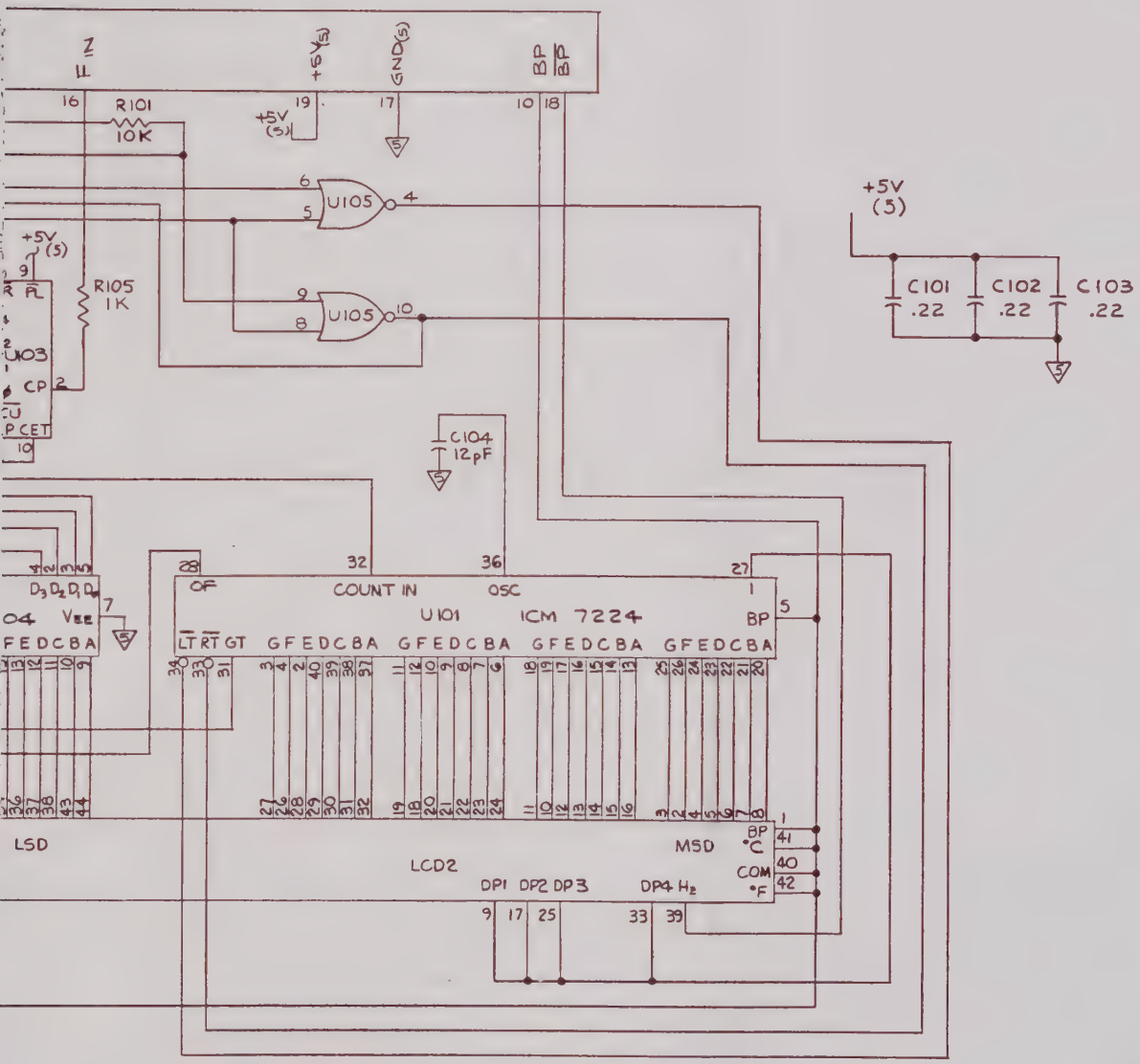
COUNTER CONTROL



/31)

CH
1/34)

ET
1/33)



AUDIO FREQUENCY

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

PARTS LIST

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MOUNTLAKE TERRACE, WA 98043

89536 DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE .XX = ± .XXX = ± ANGLES = ±
DIMENSIONS IN INCHES x_c =
FINISH

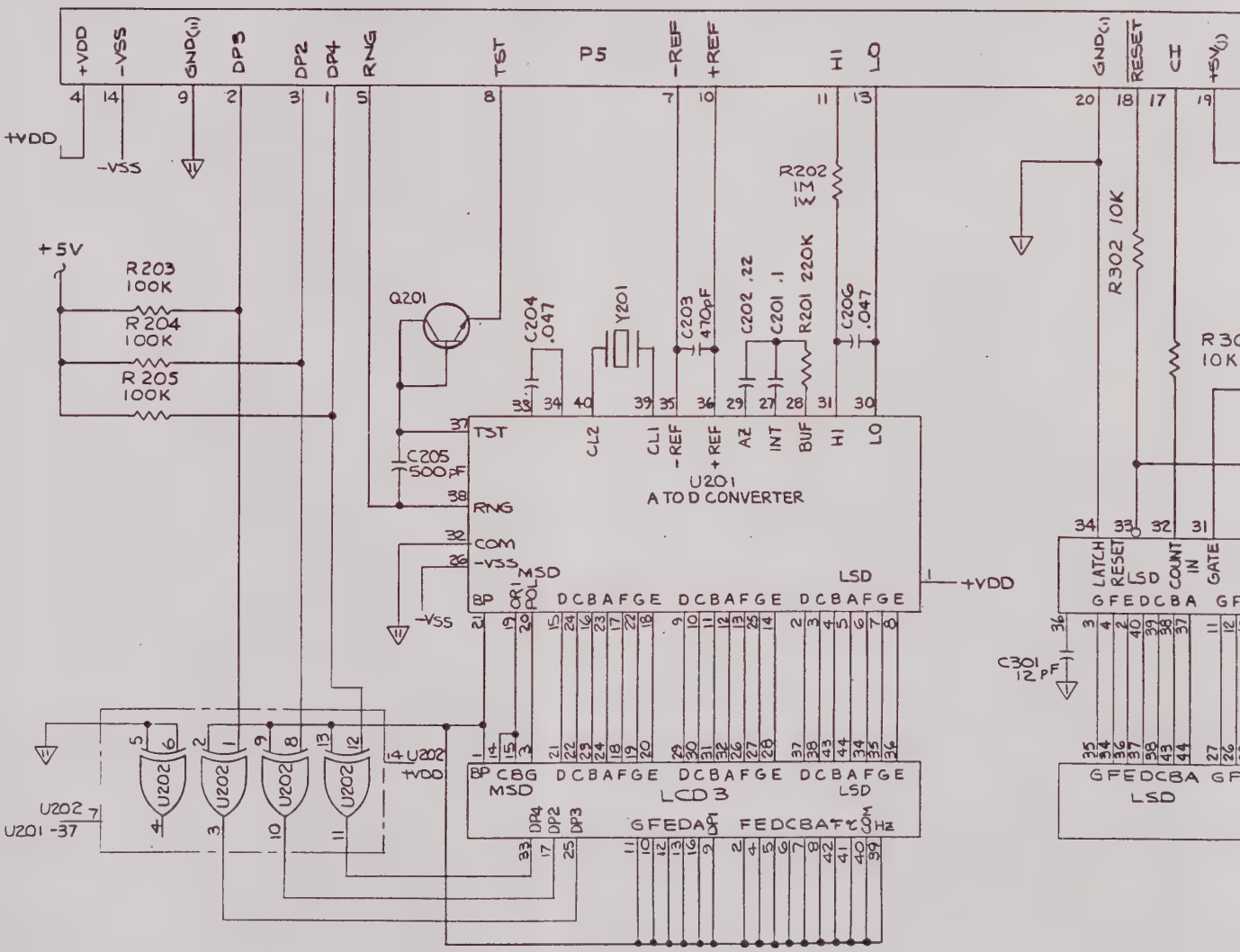
DWN	J MCRAE	10-30-80
CHK	MARK SMITH	3-10-81
PROJ ENGR	T L ROOB	6/26/84
MFG ENGR	A K WILLIS	7/5/84

SCHEMATIC, DISPLAY

BASIC		
DWG NO. SUFFIX	DRAWING NO.	PART NO.
APPLICATION	FIRST USED ON	

PART NO.	SIZE	DRAWING NO.
	D	A21-44-1003
SCALE —	SH 1 OF 2	REV B

DIST



MULTIMETER

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR

A21-44-1003 SH 2 OF 2 REV B

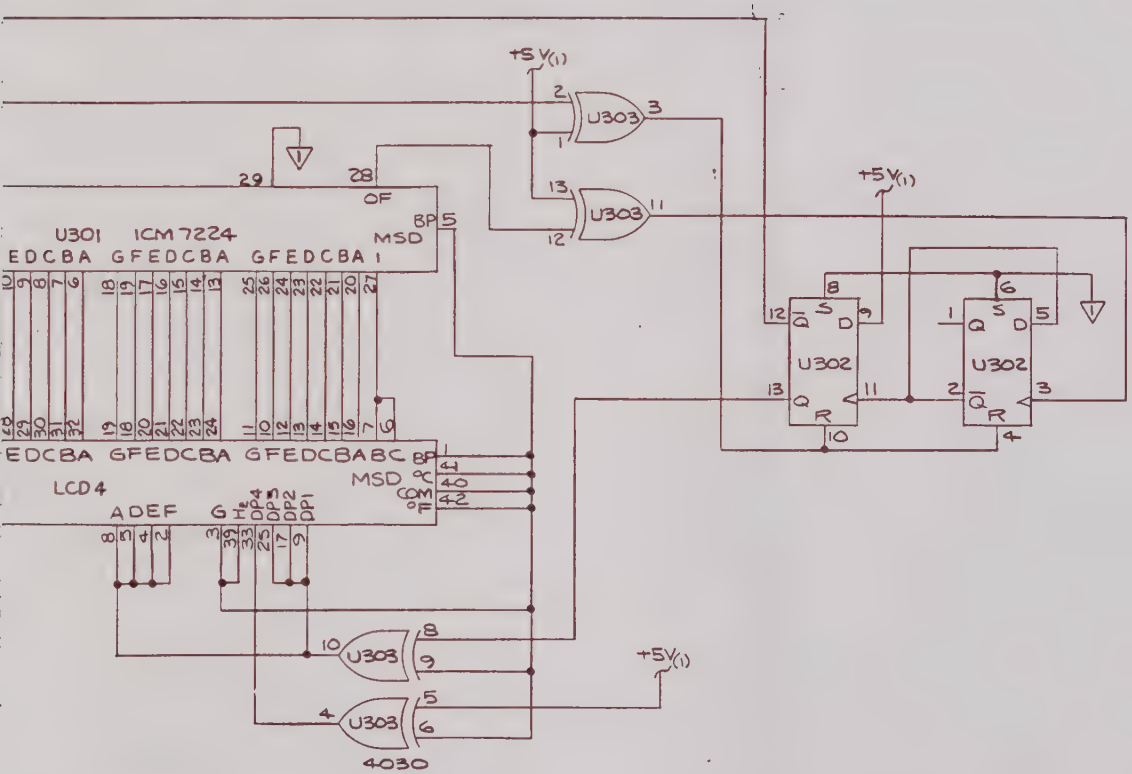
SEE SHEET 1

	I.C.	$+5_{(2)}$	$+5V_{(3)}$	$+V_{DD}$	$+5_{(1)}$	$\nabla_{(2)}$	$\nabla_{(5)}$	$\nabla_{(11)}$	$\nabla_{(1)}$	$-V_{SS}$	$\nabla_{(1)}$
THERM.	U 1	40				20					
	U 2	14				7					
AUDIO FREQ.	U101		1				35				
	U102		9,14				6,7,8 10,11				
	U103		3,4,5,6 9,16				8				
	U104		16				7,8				
	U105		14				7				
MULTI-METER	U201			1					30	26	
	U202			14				5,6			
RELAY TIMER	U301				1						29,35
	U302				9,14						6,7,8
	U303				1,5,13,14						7

+5V(1)

+5V(1)

C302 .22 C303 .22



RELAY TIMER

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES

PARTS LIST

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UNLESS OTHERWISE SPECIFIED
TOLERANCE .XX = ± .XXX = ± ANGLES = ±
DIMENSIONS IN INCHES X_C =

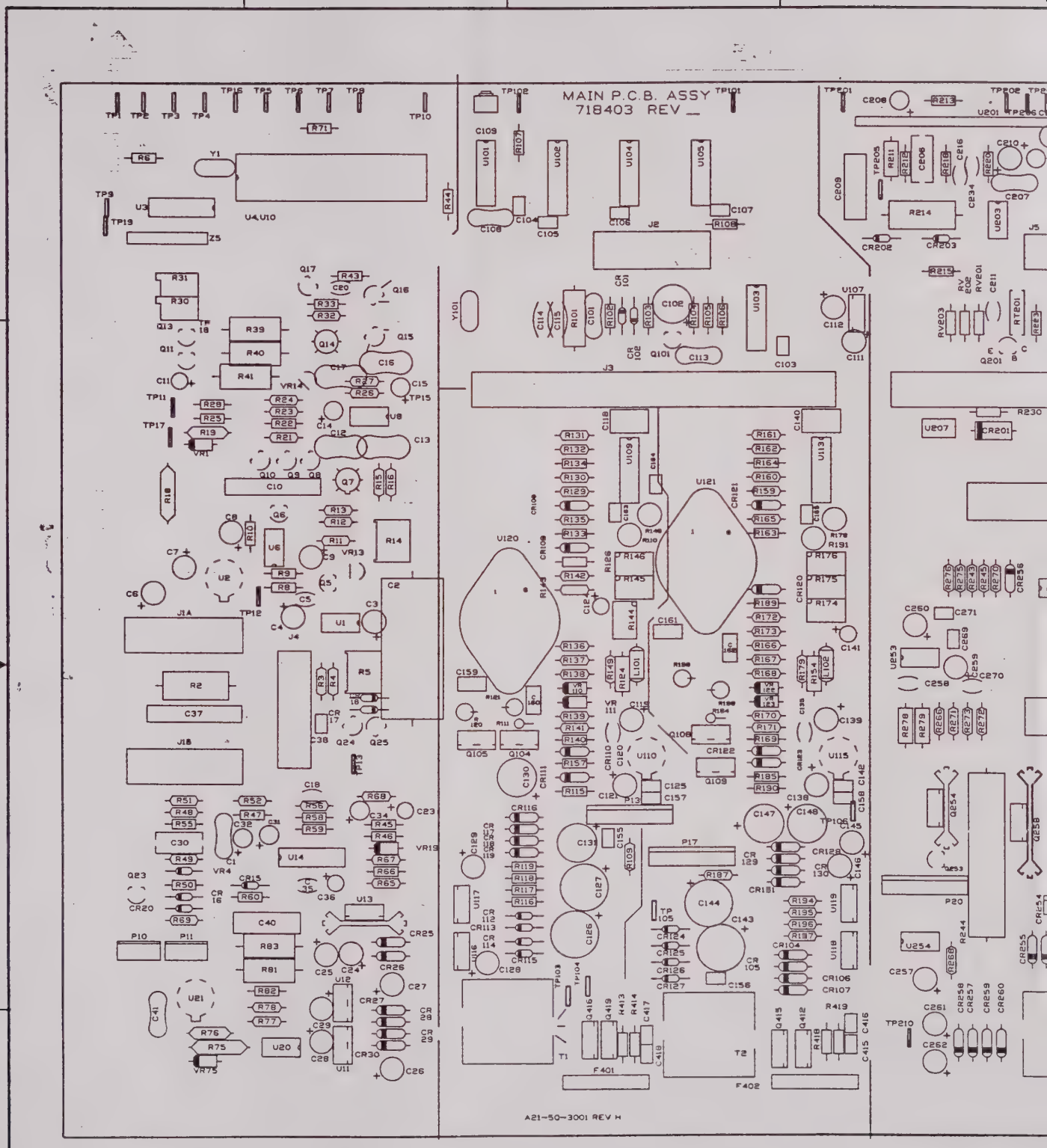
DWN	J MCRAE 10-30-80
CHK	MARK SMITH 3-10-81
PROJ ENGR	
MFG ENGR	
FINISH	

SCHEMATIC, DISPLAY

BASIC		
DWG NO.	DRAWING NO.	PART NO.
SUFFIX	FIRST USED ON	
APPLICATION		

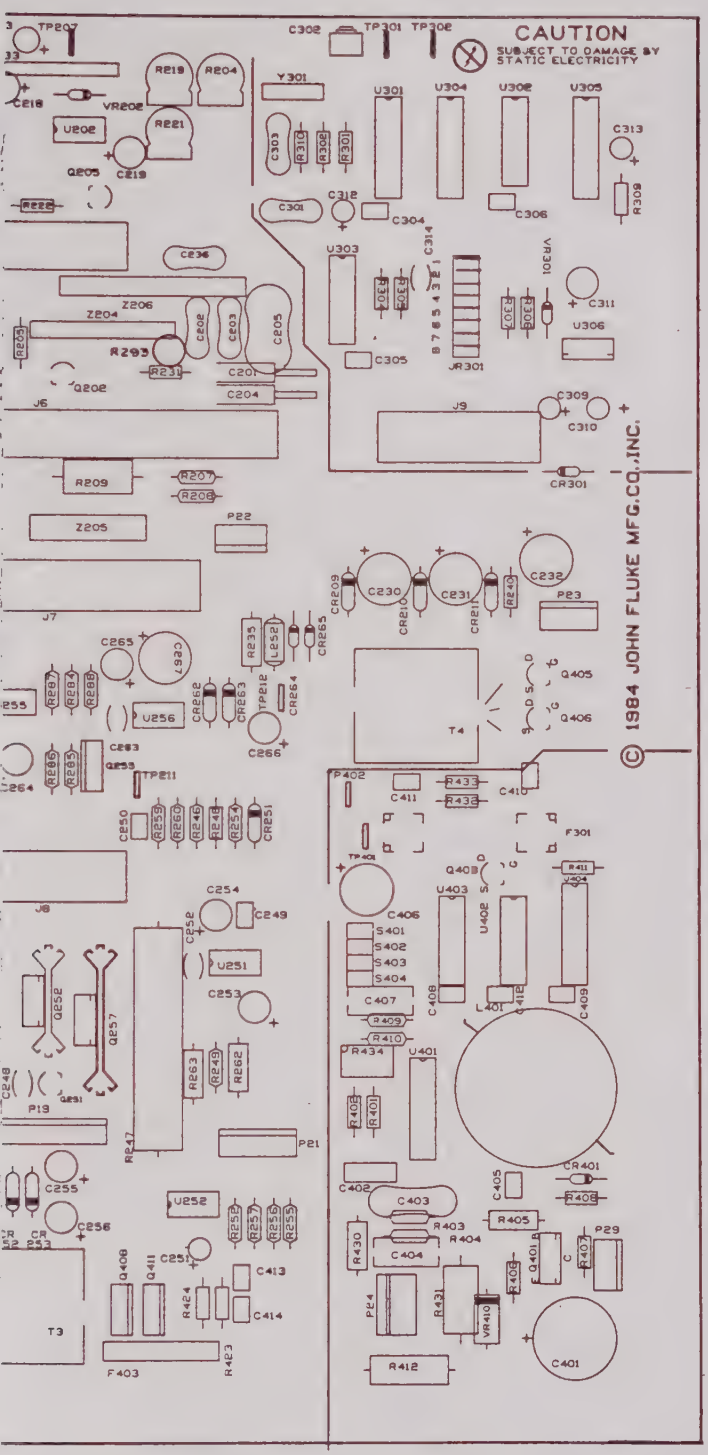
PART NO.	SIZE	DRAWING NO.
	D	A21-44-1003
SCALE —	SH 2 OF 2	REV B

DIST



CAUTION
SUBJECT TO DAMAGE B
STATIC ELECTRICIT

J F FORM A4500 Rev 2-82



REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
–	RELEASE TO PRODUCTION		DCB 8/3/84	9/5/84	9/5/84	9/5/84
A	DCO 21493 - DELETED VR402-VR409, R415-R417, R420-R422, R425-R427, Q408, Q411, Q412, Q416, Q419. ADDED C135-C136, TP103-TP106, TP210-TP212, TP401 & TP402. DCO 22154 - ADDED C110 TO CKT 1.		DCB 4/11/85	NJC 10/27/86	AKW 1/13/92	AKW 1/13/92
B	DCO # 36792. REVISED UPDATED SCREEN. INCORPORATED DCO # 38514.		VE 6/28/89 11/20/89	NJC 5/11/90	AKW 5/10/93	BLG 7/22/93

A21-50-1601 SH 1 OF 1 REV B

NOTES: UNLESS OTHERWISE SPECIFIED

1. SEE A21-50-1001 FOR SCHEMATIC.

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

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FLUKE

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P.O. BOX C9090
EVERETT, WA 98206

89536

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TOLERANCE: XX = ± XXX = ± ANGLES = ±

DIMENSIONS IN INCHES

DWN	D. C. BARRETT	8/3/84
CHK		9/5/84
PROJ ENGR	T. L. ROBB	
MFG ENGR	A. R. WEISS	8/6/84
FINISH		

REF. DESIGNATOR, MAIN P.C.B. ASSY

PART NO.	SIZE	DRAWING NO.
	D	A21-50-1601

SCALE NONE SH 1 OF 1 REV B

BASIC DWG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

PROPRIETARY

DIST

NOTES: UNLESS OTHERWISE SPECIFIED

1. ASSEMBLE PER S.O.P. 111.8
2. SEE A21-50-1001 FOR SCHEMATIC
3. LEADS TO BE .100 LONG MAX.
4. REVISIONS TO THIS DRAWING TO BE MADE THROUGH CAD DATA BASE #673.
5. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1
6.
7.
8.
9.
10.
11. R6,R25,R71,R108,R218,R240,R306.
12. R44,R46,R47,R60,R107,R304,R305,R309,R310
13. R45,R231
14. R55,R401,R402
15.
16.
17. R133,R163
18. R205, R223
19. R212,R302
20. R222, R301
22. R126, R189
23. R413,R414,R418,R419,R423,R424,R432,R433.
24. R249,R266
25. R115, R190
26. R140, R157, R169, R185
27.
28. R13,R141,R143,R171,R173
29. R11,R12,R26,R27
31. R129,R130,R159,R160,R243,R246,R256,R272
32. R131,R132,R161,R162.
33. R135,R165
34. R136,R137,R166,R167
35. R138,R149,R168,R179
36. R139,R170
37. R245,R248,R254,R270
38. CR15,CR16,CR17,CR18,CR20,CR251,CR256
39.
40.
41.
42. U8,U251,U253

1	108	454678		I.C., PWM, 3524	U401
1	107	412999		I.C.,DIGITAL,74LS109	U305
1	106	507640		I.C.,DIGITAL,4060B	U301
1	105	355172		I.C., DIGITAL, 4001B	U402
1	104	504449		I.C.,DIGITAL,74LS132	U303
1	103	340125		I.C.,DIGITAL,4015B	U304
1	102	355198		I.C.,DIGITAL,4011UBE	U105
1	101	404681		I.C.,DIGITAL,4069UBE	U104
1	100	393058		I.C.,DIGITAL,74LS04	U103
1	99	403568		I.C.,DIGITAL,4017B	U102
1	98	643098		I.C.,DIGITAL,ICM7207A	U101
1	97	473389		I.C.,DIGITAL,74C906	U3
1	96	418780		I.C.,LINEAR,LF351N	U203
	95				
1	94	387233		I.C.,LINEAR,LM339N	U14
1	93	418566		I.C.,LINEAR,LM358N	U256
3	92	685164		I.C.,LINEAR,LF412	42.
1	91	472779		I.C.,LINEAR,LF356N	U6
1	90	352195		I.C.,LINEAR,LM311	U1
1	89	393041		I.C.,DIGITAL,74LS02	U302
1	88	340117		I.C., DIGITAL, 4013A	U403
1	87	381830		I.C., DIGITAL, 4050B	U404
	86				
	85				
	84				
	83				
	82				

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

7	81	203323		DIODE, 1N4448	38.
	80				
	79				
	78				
	77				
4	76	706176		RES.,MF,1/8W,1%,39.2K	37.
1	75	719823		RES.,MF,1/8W,1%,20K	R403
1	74	719559		RES.,MF,1/8W,1%,1.21K	R404
	73				
1	72	461970		RES.,MF,1/8W,.1%,90Ω	R208
1	71	461988		RES.,MF,1/8W,.1%,900Ω	R207
2	70	714923		RES.,MF.1/8W,1%,4.99K	36.
4	69	272153		RES.,MF,1/8W,1%,43.2K	35.
4	68	720342		RFS.,MF,1/8W,1%,5.11K	34.
2	67	234963		RES.,MF,1/8W,1%,19.1K	33.
4	66	720276		RES.,MF,1/8W,1%,4.75K	32.
8	65	719476		RFS.,MF,1/8W,1%,10K	31.
1	64	235283		RES.,MF.1/8W,1%,309K	R65
1	63	706119		RES.,MF,1/8W,1%,226K	R69
1	62	288530		RES.,MF,1/8W,1%,64.9K	R68
	61				
1	60	719609		RES.,MF,1/8W,1%,133K	R52
1	59	720482		RES.,MF,1/8W,1%,681K	R49
1	58	241083		RES.,MF,1/8W,1%,150K	R48
1	57	237230		RES.,MF,1/8W,1%,61.9K	R77
4	56	352245		RES.,MF,1/8W,.1%,10.02K	29.
1	55	719872		RES.,MF,1/8W,1%,221Ω	R24
1	54	719898		RES.,MF,1/8W,1%,22.1K	R23
1	53	719864		RFS.,MF,1/8W,1%,215K	R21
1	52	719732		RES.,MF,1/8W,1%,169K	R16
1	51	720318		RES.,MF,1/8W,1%,49.9Ω	R15
5	50	719468		RFS.,MF,1/8W,1%,1K	28.
	49				
	48				
	47				
	46				
1	45	572594		RES.,CC,1/4W,5%,68Ω	R407
1	44	572792		RES.,CC,1/4W.5%,2M	R82
	43				
	42				
	41				
	40				
4	39	573147		RES.,CF,1/4W,5%,560	26.
1	38	573337		RFS.,CF,1/4W,5%,5.6K	R106
1	37	573071		RFS.,CF,1/4W,5%,270Ω	R105
2	36	573444		RES.,CF,1/4W,5%,20K	25.
1	35	573345		RES.,CF,1/4W,5%,6.2K	R307
2	34	573055		RES.,CF,1/4W,5%,200Ω	24.
1	33	573600		RES.,CF,1/4W,5%,150K	R28
1	32	641357		RES.,CF,1/4W,5%,27Ω	R408
8	31	573485		RES.,CF,1/4W,5%,33K	23.
2	30	442095		RES.,CF,1/4W,5%,3.9Ω	22.
	29				
1	28	573311		RES.,CF,1/4W,5%,4.7K	R230

A21-50-4001AI SH 1 OF 2 REV F1

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE: DWN	CHK	PROJ ENGR	MFG ENGR
A	DELETED ITEM 5 & 17. REV CKTY ITEM 1.		DCB 4/27/84			
B	REV CKTY. QTY ITEM 7 WAS 11. DEL "R308" & ITEM 82.	DCO# 19468	DCB 7/23/84			
—	RELEASE TO PRODUCTION		DCB 7/25/84		8/1/84	7/27/84
C	DCO 21993-SHT 1, QTY ITEM 37 WAS 7. DEL. ITEM 84 & FLAG NOTE 26 & 41. UPDATED SHT 2. CKT. REV.		DCB 4/11/85		12/3/85	12/3/85
C1	C-2 # 22826 DEL. ITEM 43 & FLAG NOTE 27. C-2 # 22973 P/N ITEM 83 WAS 453599.		DCB 8/20/86		10/15/86	10/15/86
D	DCO # 23389 - QTY ITEM 18 WAS 5. ADDED ITEM 17.		DCB 8/26/86	AJC 10-27-6	10/15/86	10/15/86
E	DCO # 36792. ADDED ITEM 39. DELETED ITEM 29 & FLAGNOTE 9; DELETED ITEM 18 & FLAGNOTE 15. ITEM 19 QTY WAS 5; ITEM 21 QTY WAS 6; ITEM 30 QTY WAS 4. ADDED FLAGNOTE 26. ITEM 92 P/N WAS 478032 IC, LINEAR, MC4558. INCORPORATED DCO # 38514.	VL 7/17/89 VL 11/20/89	AK 5/7/90		5/10/90	66 5/10/90
F	DCO # 40996. SHT 1, ON P/L ITEM 7 QTY WAS 10; ADDED ITEM 5; DELETED ITEMS 9 & 27. SHT 2, ZN B-3 REFERENCE DESIGNATOR BUBBLE 5 WAS BUBBLE 7. INCORP. DCO # 41223.	VL 10/3/90 VL 10/16/90				NC 10/24/90
F1	CII DCO # 41617. "NOTE 20 DELETED" WAS ARASED FROM REV F CHANGE BLOCK.	VL 12/12/90			12/17/90	12/17/90

2	27	573675		RES.,CF,1/4W,5%,470K	20.
1	26	342659		RES.,CF,1/4W,5%,2.2M	R220
1	25	641043		RES.,CF,1/4W,5%,15Ω	R215
1	24	572883		RES.,CF,1/4W,5%,1Ω	R213
2	23	572859		RES.,CF,1/4W,5%,22M	19.
1	22	573014		RES.,CF,1/4W,5%,100Ω	R406
2	21	573691		RFS.,CF,1/4W,5%,1M	18.
2	20	573428		RES.,CF,1/4W,5%,15K	17.
1	19	573154		RES.,CF,1/4W,5%,680Ω	R104
	18				
1	17	641068		RES.,CF,1/4W,56 Ω	R103
2	16	573501		RES.,CF.1/4W,5%,39K	R59,66
1	15	573535		RES.,CF,1/4W,5%,51K	R58
3	14	573329		RES.,CF,1/4W,5%,5.1K	14.
1	13	573527		RES.,CF,1/4W,5%,47K	R50
2	12	573584		RES.,CF,1/4W,5%,100K	13.
1	11	573402		RES.,CF,1/4W,5%,12K	R72
1	10	573477		RES.,CF,1/4W,5%,27K	R10
	9				
1	8	573287		RES.,CF,1/4W,5%,3.3K	R8
9	7	573394		RES.,CF,1/4W,5%,10K	12.
7	6	573170		RES.,CF,1/4W,5%,1K	11.
1	5	573550		RES.,CF,68K.1/4W	R411
	4				
	3				
	2				
1	1	718411	A21-50-3001	P.C.B., MAIN ASSEMBLY	
QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

BASIC DWG NO SUFFIX	A21-50-4001	718403
	DRAWING NO	PART NO.
	FIRST USED ON APPLICATION	

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FLUKE

JOHN FLUKE MFG. CO., INC.
P.O. BOX C9090
EVERETT, WA. 98206

89536 DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE DIMENSIONS IN INCHES
XX = ±
XXX = ±
ANGLES = ±

DWN	D.C. BARRETT	3/20/84
CHK		8/3/84
PROJ ENGR	T. L. ROBB	8/1/84
MFG ENGR	A. K.	7/27/84
FINISH		

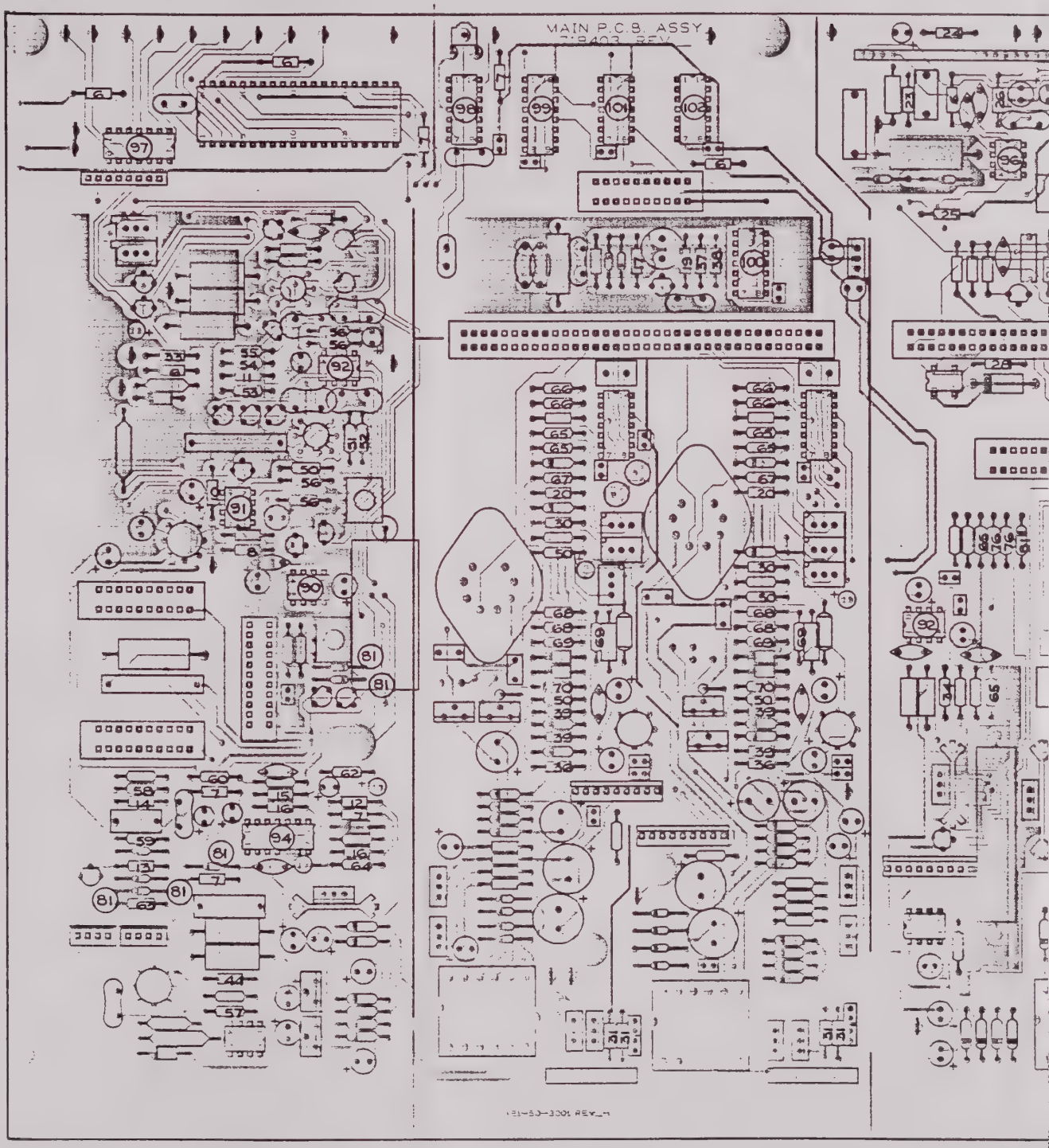
ASSEMBLY, MAIN P.C.B. (AUTO-INSERTED)

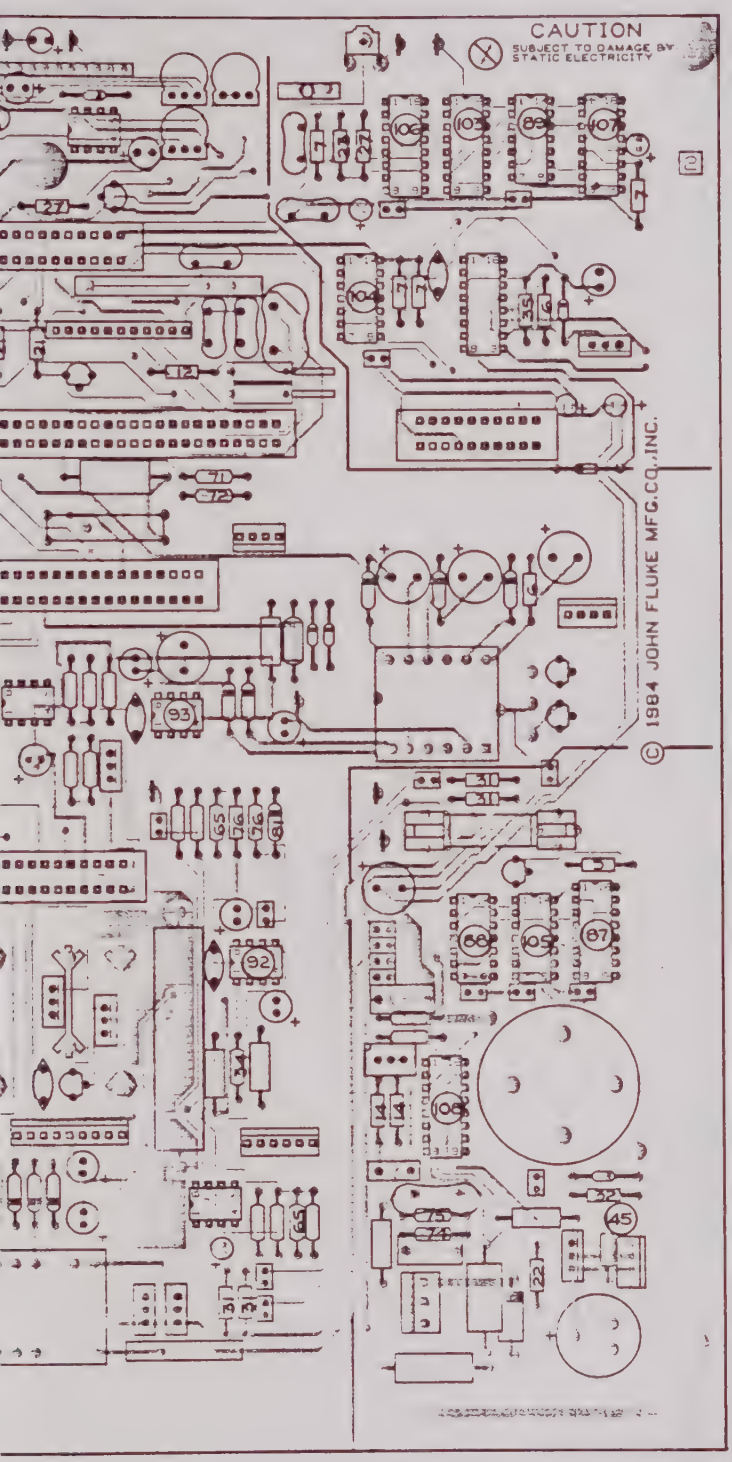
PART NO.	SIZE	DRAWING NO.
718429	D	A21-50-4001AI

SCALE — SH 1 OF 2 REV F1

PROPRIETARY

DIST


MAIN P.C.B. ASSY
8
7
6
5
D
C
B
A



REVISIONS

SEE SHEET 1 FOR REVISIONS

A21-50-4001 AI
SH 2 OF 2
REV F1

SEE SHEET 1 FOR NOTES & PARTS LIST

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

FLUKE	JOHN FLUKE MFG. CO., INC P.O. BOX C9090 EVERETT WA 98206
89536	DO NOT SCALE DRAWING
ASSEMBLY, MAIN PCB (AUTO-INSERTED)	
PART NO. 718429	SIZE D
DRAWING NO A21-50-4001 AI	
SCALE 1.5:1	SH 2 OF 2 REV F1

PROPRIETARY

DIST

NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAMS SEE A21-50-1001.
2. ASSEMBLE PER S.O.P. 111.8.
3. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INK STAMP (PERMA-DRI 177 OR EQUIVALENT).
4. LEAD LENGTH .100 MAX ON ALL PARTS EXCEPT ITEM 127. DO NOTE PREP LEADS ON ITEM 127.
5. C303 TO BE SELECTED IN TEST.
6. CLOCK ITEM 11 WITH PAINTED POLARIZING DOT FACING Q15. DISREGARD TAB ON ITEM 11.
7. SWITCH MUST BE IN THE "ON" POSITION FOR FLOW SOLDER.
8. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1
9. DO NOT VAPOR DEGREASE P.C.B. ASSEMBLY.
10. PREP OFF P.C.B. .300" MAX, 2 PLACES.
11.
12. SCREW ITEM-199 TO ITEM-186 USING ITEM-222 BEFORE FLOW SOLDER.
13. APPLY ADEQUATE RTV TO SECURE ITEM 197 IN AN UPRIGHT POSITION.
14. R111, R184.
15. R33,R102,R259,R275
16. R198, R199, R120, R121.
17. U202,U252,U254,U255
18. C157, C158
19. Q251, Q253
20. VR1, R18 (1/2W) & R19 (1/4W) MATCHED SET.
    VR75, R75 (1/2W) & R76 (1/4W) MATCHED SET
21. R262, R278
22. R263, R279
23. F401, F402, F403
24. R124, R154
25. R260, R276
26. R116, R119, R194, R197
27. R117, R118, R195, R196
28. R78, R410
29. R252, R268
30. R284, R285
31. R67, R288
32. R109, R187
33. R142, R172
34. R257, R273
35. R255, R271
36. C35, C402, C155, C156
37. R244, R247
38. R3(100K), R4(11.8K) MATCHED SET
39. R39(52K), R40(9K), R41(1K) MATCHED SET
40. R148, R178
41. R110, R191
42. R146, R176, R434
43. R144, R145, R174, R175.
44. RV201, RV202, RV203
45. C252, C258, C18, C120, C135
46. C14, C15, C229
47. C3, C4, C6, C7, C8, C9
48. C24-C29, C111, C112, C119, C121, C128, C129, C138, C139, C145, C146, C219, C253-C256, C259-C262, C265, C266, C311
49. C102, C130, C131, C147, C148, C230, C231, C232
50. C11, C23, C36, C124, C141, C251, C257, C264, C309, C310, C312, C313
51. C10, C37
52. C12, C13, C16, C17
53. C30, C206
54. C38, C103-C107, C304, C305, C306, C408, C409, C250, C271, C163, C164, C165.
55. C109, C302
56. ITEMS 60 & 127 TO BE SENT TO REWORK LINE, UNPREPPED.
57. C248, C263, C270
58. C125, C142
59. C126, C127, C143, C144
60. C203, C207
61. C201, C204
62. C208, C233
63. C20, C211, C216, C234
64. C405, C410, C411, C413-C418, C249, C269
65. C113, C301
66. CR108-111, CR120-123.
67. C118, C140
68. C159, C160, C161, C162.
69. C114, C115
70. C31, C32, C34
71. CR101, CR102
72. VR110, VR111, VR122, VR123
73. CR112-CR115, CR124-CR127, CR264, CR265
74. CR202, CR203
75. CR301, CR401
76. Q252, Q254, Q257, Q258
77. Q5, Q23, Q201, Q202
78. Q6, Q8, Q11, Q13, Q15
79. Q9, Q16, Q17, Q24, Q25
80. Q403, Q405, Q406
81. Q105, Q108
82. Q104, Q109
83. Q408, Q411, Q412, Q415, Q416, Q419.
84. U117, U119

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

A21-50-4001 A21-50-4001P SH 1 OF 4 REV J

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
A	ADDED FLAG NOTE 10. QTY ITEM 85 WAS 2. QTY ITEM 101 WAS 11. QTY ITEM 103 WAS 1. DEL ITEM 105 ADDED ITEM 219.		DCB 4/27/84			7/27/84
B	QTY ITEM 124 WAS 2. QTY ITEM 213 WAS 25. ADDED ITEM 137. P/N ITEM 215 WAS 256156. P/N ITEM 217 WAS 110395. DEL. ITEM 216.	DCO# 19468	DCB 7/25/84			7/27/84
–	RELEASE TO PRODUCTION		DCB 7/28/84		8/1/84	8/1/84
C	DCO 21493 & DCO# 22754 - IMPLEMENTED. SEE DCO'S FOR DETAIL.		DCB 8/22/86		10/13/86	10/13/86
D	DCO# 21101 - P/N ITEM 79 WAS 461483.		DCB 8/22/86		10/13/86	10/13/86
D1	C-2 # 22826 - ADDED ITEM 28.		DCB 8/25/86		9/1/86	9/1/86
E	DCO# 23589 - P/N ITEM 123 WAS 216986.		DCB 9/25/86	AJC 10-27-6	10/31/86	10/31/86
F	DCO # 36792. ADDED PREP LEVEL TO DRAWING. EXTENSIVELY REVISED SEE DCO 36792 FOR DETAILS.		VL 7/14/89		5/18/90	5/18/90
G	INCORPORATED DCO # 38514. INCORPT. DCO # 38773.	VL 11/28/89 VL 12/15/89			6/14/90	6/14/90
H	INCORPT. DCO # 39519. INCORPT. DCO # 39555.	VL 4/12/90	AJC 5/17/90		6/1/90	6/1/90
J	DCO # 40996. ON P/L ITEM 134 P/N WAS 512848; ADDED ITEMS 15, 16 & 226. REVISED NOTE 4 NOW BECAME FLAGNOTE 4; ADDED FLAGNOTE 99 TO DRAWING. ADDED "APPLY RTV..... RTV 3140" WRITTEN INSTRUCTIONS TO DETAIL XI. INCORPT. DCO # 41223.	VL 10/3/90 VL 10/16/90				AJC 11/19/90

U116, U118

U13, U107, U306

U109, U113

U120, U121

U110, U115

L101, L102

S401-S404

P10, P11, P22, P23; P29

P13, P17, P19, P20

J1A, J1B, J2, J4, J5, J8, J9

TP1-TP13, TP15-TP19, TP101-TP106, TP201-TP203, TP205-TP207, TP210-TP212, TP301, TP302, TP401, TP402

CR25-30, 104-107, 116-119, 128-131, 209, 210, 211, 252-255, 257-260, 262, 263.

LIFT 1 LEAD OF CAP, ITEM 127 CLOSEST TO NEW ITEM 60, POT. SOLDER 2 LEADS OF POT INTO HOLE THAT CAP LEAD CAME OUT OF. TIE THE REMAINING POT LEAD TO CAP LEAD AND LEAVE IN AIR AS SHOWN IN DETAIL XI, SHT 4.

PLACE DECAL, ITEM 226, TO PWB ASSEMBLY APPROPRIATELY IN AREA SHOWN AFTER FLOWSOLDER.

PARTS LIST CONT'D SHEET 2

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES
2	54	733469		RES.,WW,10W,5%,25Ω	37.
1	53	659060		RES.,WW,2W,10%,.04Ω	R431
1	52	461939		RES.,WW,1/8W,1%,100Ω	R83
1	51	461921		RES.,WW,1/8W,1%,6.2K	R81
	50				
1	49	268789		RES.,MF,1/8W,1%,10Ω	R32
2	48	168286		RES.,MF,1/8W,1%,30.1K	35.
2	47	221663		RES.,MF,1/8W,1%,9.09K	34.
2	46	379040		RES.,MF,1/8W,1%,9.31K	33.
2	45	441436		RES.,CF,1/8W,1%,180Ω	32.
1	44	241471		RES.,MF,1/8W,1%,27.4K	R409
2	43	293472		RES.,MF,1/8W,1%,100K	31.
1	42	347070		RES.,MF,1/8W,1%,18.2K	R287
1	41	288522		RES.,MF,1/8W,1%,511K	R286
2	40	309757		RES.,MF,1/8W,1%,51.1K	30.
2	39	241380		RES.,MF,1/8W,1%,97.6K	29.
2	38	268417		RES.,MF,1/8W,1%,6.81K	28.
1	37	293605		RES.,MF,1/8W,1%,10.2K	R56
1	36	241372		RES.,MF,1/8W,1%,38.3K	R51
4	35	289983		RES.,MF,1/8W,1%,2.61K	27.
4	34	328005		RES.,MF,1/8W,1%,237Ω	26.
2	33	291393		RES.,MF,1/8W,1%,33.2K	25.
2	32	697110		RES.,CF,1/4W,5%,20K	14
2	31	161406		RES.,CC,1/2W,10%,3.9K	24.
1	30	109389		RES.,CC,1W,10%,10K	R412
1	29	187880		RES.,CC,1/2W,5%,5.6K	R235
4	28	572842		RES.,CC,1/4W,5%,10M	15.
1	27	109124		RES.,CC,1/2W,5%,560Ω	R430
2	26	109165		RES.,CC,1/2W,5%,10K	22
1	25	170704		RES.,CC,1/2W,5%,910Ω	2405
2	24	218719		RES.,CC,1/2W,5%,1.3Ω	21.
4	23	267666		RES.,CC,.5W,5%,2.2Ω	16
1	22	285056		RES.,CC,2W,5%,100K	R214
1	21	108233		RES.,CC,1/2W,10%,22M	R211
1	20	109397		RES.,CC,1W,10%,100K	R101
1	19	221606		RES.,CC,1/4W,5%,16K	R43
1	18	110015		RES.,CC,2W,10%,47K	R2
	17				
2	16	342634		RES.,CF,470K,1/4W,5%	R134, R164
1	15	442418		RES.,CF,43K,1/4W,5%	R9
2	14	515635	8050A-2007	SUPPORT, HYBRID	
	13				
1	12	480897	53-5026	HYBRID,RMS CONVERTER	U201
1	11	476911	2180A-4501	DUAL FET, SELECTED	Q14
2	10	377283	8600A-4502	ZENER REFERENCE SET	20.
1	9	490888	2030A-6402	CHOKE	L401
1	8	735100	A21-50-6304	TRANSFORMER,INVERTER	T4
1	7	735092	A21-50-6303	TRANSFORMER, INVERTER	T3
1	6	775056	A21-50-6302	TRANSFORMER, INVERTER	T2
1	5	775049	A21-50-6301	TRANSFORMER, INVERTER	T1
	4				
	3				
	2				
1	1	718429	A21-50-4001AI	ASSY,MAIN P.C.B.(AI)	

PARTS LIST

2590A	2590A-5001	717595
BASIC	A21-50-5001	716233
DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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FLUKE 89536

JOHN FLUKE MFG. CO., INC. P.O. BOX C9090 EVERETT, WA 98206

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED

TOLERANCE: XX = ± XXX = ± ANGLES ± 1

DIMENSIONS IN INCHES

FINISH

DWN	D.C. BARRETT	3/26/84
CHK		8/8/84
PROJ ENGR	T.L. ROEB	8/11/84
MFG ENGR	A.R. WEISS	7/27/84

ASSEMBLY, MAIN P.C.B.

PART NO.	SIZE	DRAWING NO
718403	D	A21-50-4001
868559		A21-50-4001P
SCALE —	SH 1 OF 4	REV J

PROPRIETARY

D1-87

1	226	873245		DECAL, PATENT 4445111, IDENT.	
	225				
2	224	561431		FUSE CLIP, PWB, 1/4X1-1/4	
	223				
4	222	177022		SCREW, SEMS, S.S 6-32 x .375"	
4	221	328047		SPACER, SWAGED, HEX	
7	220	393785		P-NUT, #6-32	
2	219	285346		SPACER, DOG BONE	
4	218	155473		SPACER, CERAMIC, 1/2"	
5	217	146225		WASHER, FLAT, #4	
	216				
5	215	745869		PUSH-RIVIT, PLASTIC	
1	214	380022		CONN., HEADER, 3POS	P24
37	213	512889		CONNECTOR, TEST POINT	96.
1	212	520148		CONN., EDGE, 44 POS	J7
7	211	520189		CONN., EDGE, 20 POS	95.
2	210	631309		CONN., EDGE, 72 POS	J3,6
4	209	631168		CONN., POST HEADER, 9 POS	94.
1	208	631176		CONN., POST HEADER, 6 POS	P21
5	207	631184		CONN., POST HEADER, 4 POS	93.
1	206	429282		SOCKET, 40 PIN DIP	
[illegible]	205				
2	204	370304		SOCKET, 14 PIN DIP	
1	203	495507		HEADER, PROGRAMMED	JR301
2	202	386235		HEATSINK	
3	201	524934		HEATSINK, TO-220	
4	200	733808		SWITCH, SPST	92.
2	199	740738		HEAT DIS, HORIZONTAL	
	198				
1	197	519173		CRYSTAL, 38.4KHZ	Y301
1	196	643056		CRYSTAL, 5.24288MHZ	Y101
1	195	474072		CRYSTAL, 4MHZ	Y1
	194				
	193				
	192				
	191				
1	190	174755		CHOKE, 100uH	L252

	189				
2	188	461533		INDUCTOR, 560uH	91.
	187				
2	186	855135		I.C, OP AMP OPA541BM	89
	185				
1	184	418582		I.C., DIODE BRIDGE, VM08	U207
	183				
	182				
	181				
	180				
2	179	392902		I.C., LINEAR, 1436	90.
	178				
2	177	643080		I.C., LINEAR, ICL 8038	88.
1	176	225961		I.C., LINEAR, AD3092	U21
3	175	428847		I.C., VOLT. REG., 7805	87.
1	174	413187		I.C., VOLT. REG., 7815	U12
1	173	413179		I.C., VOLT. REG., 7915	U11
1	172	413740		I.C., LINEAR, LM307	U20
1	171	429837		I.C., BIFET LF365H	U2
2	170	460410		I.C., VOLT, REG., ADJ. LM317	85.
2	169	707661		I.C., VOLT. REG., ADJ. LM337	84.
4	168	472845		I.C., LINEAR, VOLT-REF, 2.5V	17.
2	167	640862		TRANSISTOR, NPN, SEL.	19
6	166	586107		TRANSISTOR, POWER FET	83.
1	165	325753		TRANSISTOR, PNP, D45C5	Q401
1	164	381731		TRANSISTOR, NPN, MPSU10	Q255
1	163	195974		TRANSISTOR, PNP, 2N3906	Q205
2	162	685453		TRANSISTOR, PNP, TIP-30C	82.
2	161	685446		TRANSISTOR, NPN, TIP-31C	81.
3	160	7410[illegible]		TRANSISTOR, FET, VN0606M	80.
1	159	403634		TRANSISTOR, FET	Q101
5	158	343830		TRANSISTOR, FET	79.
1	157	419283		TRANSISTOR, DUAL FET	Q7
5	156	376475		TRANSISTOR, FET	78.
4	155	218396		TRANSISTOR, NPN, 2N3904	77.
1	154	429977		TRANSISTOR, FET	Q10
4	153	386128		TRANSISTOR, NPN, TIP-120	76.
	152				
	151				
	150				
1	149	650358		DIODE, T.V.S., 36V, 1N5646	VR410
1	148	181073		DIODE, ZENER, 22V, 1N969B	VR4
1	147	180455		DIODE, ZENER, 4.3V, 1N749A	VR202
2	146	483701		DIODE, 5FF10	75.
2	145	348177		DIODE, SI, FD7223	74.
1	144	347559		DIODE, SI, 1N5400	CR201
10	143	495739		DIODE, 3FF10	73.
4	142	357848		DIODE, ZENER, 64.V, 1N4578	72.
2	141	381806		DIODE, SI, 1N3062	71.
1	140	393579		DIODE, ZENER, 6.4 V, 1N4567	VR19
2	139	348482		DIODE, CURRENT REG.	VR13, 14
1	138	277236		DIODE, ZENER, 5.6V, 1N752A	VR301
31	137	379412		DIODE, SILICON, IN4933	97
8	136	707075		DIODE, IN4007	66

CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICIT

	135				
1	134	448449		CAP.,CERAM,50V,22PF	C412
3	133	161919		CAP.,TANT,35V,1uF	70.
2	132	355420		CAP.,CERAM,1KV,.05uF	69.
	131				
4	130	436782		CAP,CERAM,50V,1.uF	68
1	129	148494		CAP.,MICA,500V,100pF	C236
1	128	192518		CAP.,MICA,500V,3300pF	C205
4 1	127	148452		CAP.,MICA,500V,270pF	C202
2	126	739987		CAP.,POLY,50V,.0047uF	67.
1	125	148387		CAP.,MICA,500V,1000pF	C403
1	124	368613		CAP.,CERAM,1KV,470pF	C314
1	123	148551		CAP.,MICA,500V,22pF	C108
1	122	175224		CAP.,MICA,500V,12pF	C101
2	121	175216		CAP.,MICA,500V,10pF	65.
1	120	436113		CAP,POLY,100V,.22uF	C404
1	119	393439		CAP.,POLY,100V,.1uF	C407
1	118	494575		CAP.,ALUM,25V,470uF	C406
11	117	407361		CAP.,CERAM,100V,.01uF	64.
1	116	512657		CAP.,ALUM,100V,190uF	C401
1	115	614362		CAP.,ALUM,50V,22uF	C267
1	114	161927		CAP.,TANT,20V,2.2uF	C218
4	113	149153		CAP.,CERAM,100V,.01uF	63.
1	112	436840		CAP.,ALUM,35V,22uF	C210
1	111	448183		CAP.,POLY,1KV,.022uF	C209
2	110	193623		CAP.,TANT,15V,10uF	62.
2	109	435016		CAP.,VARI,1.7KV,.25-1.5pF	61.
2	108	148478		CAP.,MICA,500V,150pF	60
4	107	641225		CAP.,ALUM,100V,100uF	59
2	106	354852		CAP.,CERAM,50V,33pF	58
	105				
	104				
3	103	148924		CAP.,CERAM,25V,.05uF	57.
2	102	404301		CAP.,VARI,250V,6-50pF	55
16	101	519157		CAP.,CERAM,50V,.22uF	54
1	100	369124		CAP.,POLY,100V,.47uF	C40
1	99	160317		CAP.,MICA,500V,33pF	C41
4	98	309849		CAP.,CERAM,50V,.22uF	36
2	97	162008		CAP.,POLY,250V,.047uF	53
2	96	528604		CAP.,CERAM,100V,820pF	18
4	95	177980		CAP.,MICA,500V,430pF	52
2	94	306522		CAP.,POLY,100V,2.2uF	51
1	93	106732		CAP.,CERAM,500V,.0012uF	C5
12	92	602342		CAP.,ALUM,50V,1uF	50
8	91	603977		CAP.,ALUM,35V,47uF	49
28	90	603985		CAP.,ALUM,35V,10uF	48
6	89	614024		CAP.,ALUM,35V,15uF	47
3	88	330662		CAP.,TANT,20V,10uF	46
1	87	364042		CAP.,POLY,50V,.47uF	C2
1	86	148536		CAP.,MICA,500V,47pF	C1
5	85	175232		CAP.,CERAM,100V,.005uF	45
	84				
	83				
	82				

1	81	474999		RES. NET.,CUSTOM	Z204
1	80	461491		RES. NET.,1Ω,.9 Ω	Z205
1	79	508762	54-4043T	RES. NET.,	Z206
1	78	413286		RES.NET.,8 PIN SIP,47K	Z5
3	77	460915		FUSE,125V,3.0A FA	23
	76				
1	75	446849		THERMISTOR	RT201
1	74	369819		FUSE,250V,1A, FAST	
3	73	447672		VARISTOR, 10%, 430V	44.
	72				
1	71	720995		RES.,VARI,20T,500Ω	R30
1	70	485052		RES.,VARI,1T,1M	R221
1	69	478883		RES.,VARI,1T,5K	R219
1	68	474973		RES.,VARI,1T,200Ω	R204
4	67	381921		RES.,VARI,20T.200K	43.
3	66	393728		RES.,VARI,20T.1K	42.
2	65	193045		RES.,VARI,1T,100K	41.
2	64	193060		RES.,VARI,1T,1K	40.
1	63	474387		RES.,VARI,1T,500K	R14
1	62	275743		RES.,VARI,1T,200Ω	R5
1	61	721001		RES.,VARI,20T,25K	R31
56 1	60	226092		RES.,VARI,CERM.,10K	R293
1	59	375782		RES.,SET.MF.MATCHED	39.
1	58	479030		RES.,SET,MF,MATCHED	38.
	57				
	56				
1	55	461962		RES.,WW,3W,.15%,9Ω	R209
QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

A21-50-4001 A21-50-4001P SH 2 OF 4 REV J

2590A	2590A-5001	717595
BASIC	A21-50-5001	716233
DWG NO SUFFIX	DRAWING NO FIRST USED ON	PART NO.
APPLICATION		

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JOHN FLUKE MFG. CO., INC.
P.O. BOX C9090
EVERETT, WA 98206

89536

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TOLERANCE
DIMENSIONS IN INCHES
XX ± ±
XXX ± ±
ANGLES ±

DWN	D.C. BARRETT	3/26/84
CHK	A Cuevas II	10-27-6
PROJ ENGR	T.L. ROBB	8/16/84
MFG ENGR	A. KWEKS	7/27/84

FINISH

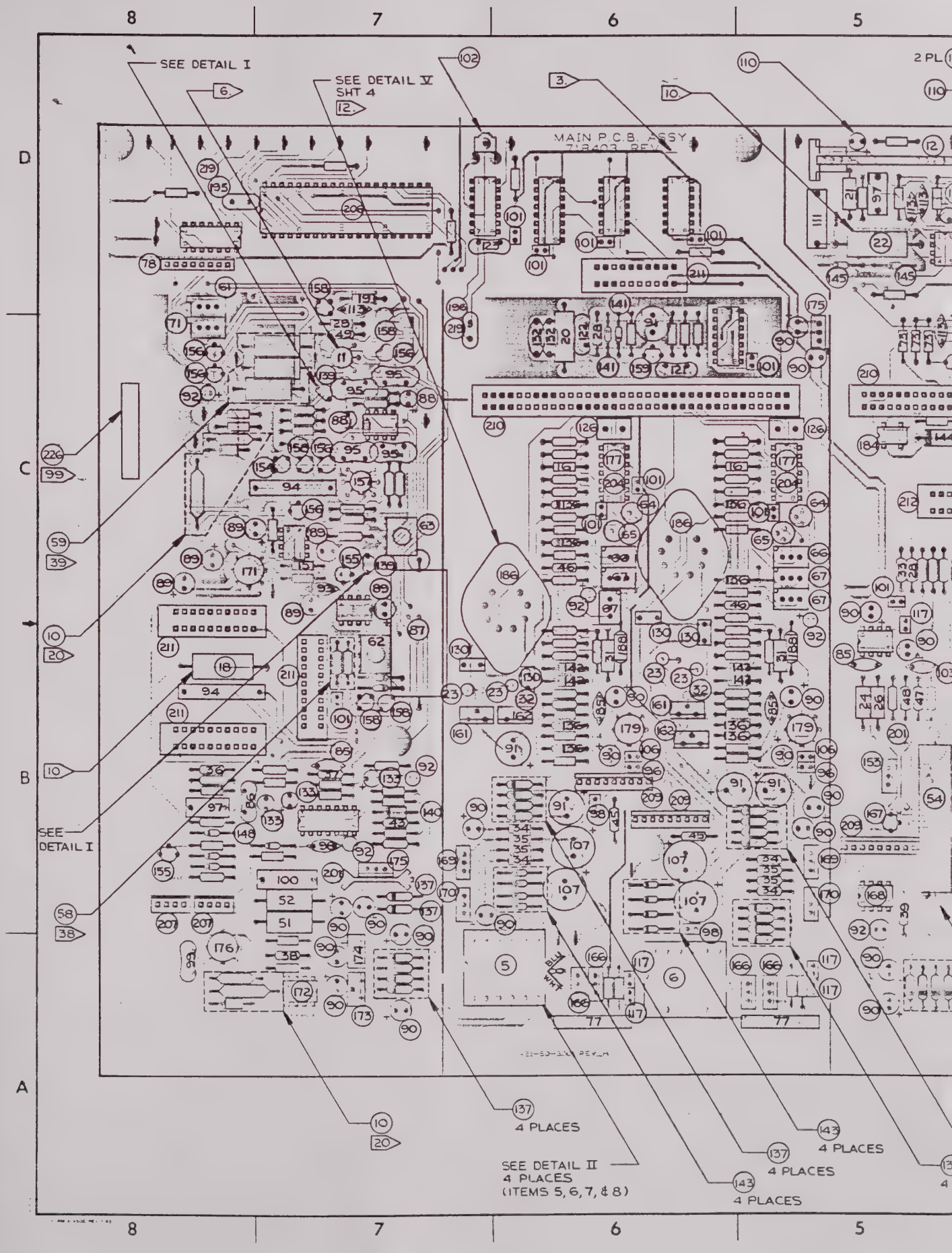
ASSEMBLY MAIN P.C.B.

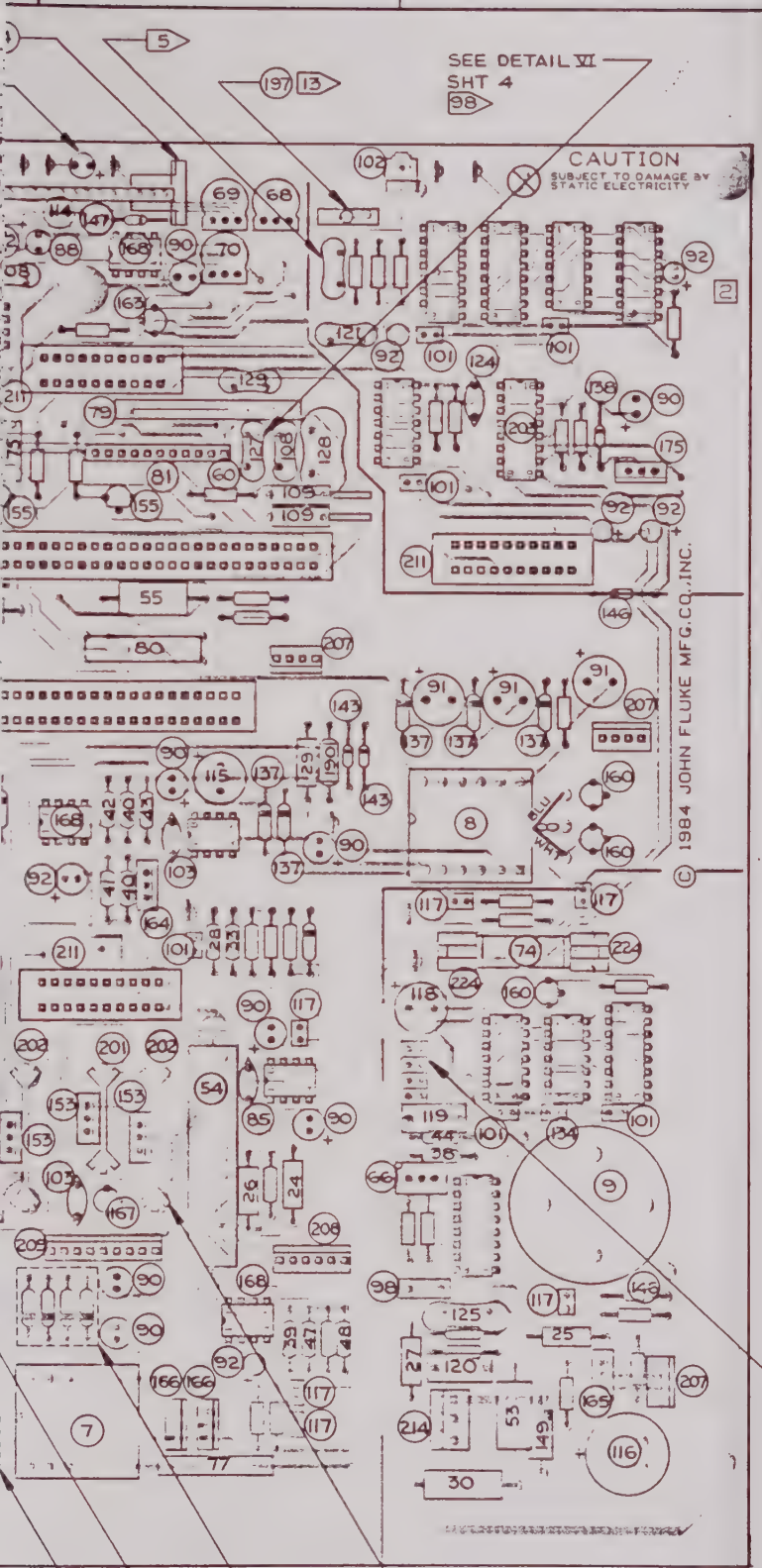
PART NO.	SIZE	DRAWING NO
718403	D	A21-50-4001
868559		A21-50-4001P

SCALE — SH 2 OF 4 REV J

PROPRIETARY

DIST


MAIN P.C.B. ASSY
SEE DETAIL I
SEE DETAIL V
SHT 4
SEE DETAIL I
SEE DETAIL II
4 PLACES
(ITEMS 5, 6, 7, & 8)
4 PLACES
4 PLACES
4 PLACES
4 PLACES
2 PL
8
7
6
5
D
C
B
A



A21-50-4001
A21-50-4001P
SH 3 OF 4 REV J

REVISIONS

SEE SHEET 1 FOR REVISIONS

PLASTIC PACKAGE

METAL PACKAGE

CLOCKING DETAIL

DETAIL I
2 PLACES

CHAMFER DENOTES PIN 1

WHITE & BLUE TWISTED PAIRS 2" LG ; 3/16" STRIP - BACK (ITEMS 5 & 8 ONLY)

DETAIL II
BOTTOM VIEW
ITEMS 5, 6, 7, & 8

BLUE WIRE, 2" LG ; 3/16" STRIP - BACK

TRANSISTOR -153, OR -175

215 5 PL

201
202

DETAIL III
TYPICAL 9 PLACES

217 5 PL

54 REF

RTV 2 PL

218 2 PL

DETAIL IV
TYPICAL 2 PLACES

200
7.
4 PLACES

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

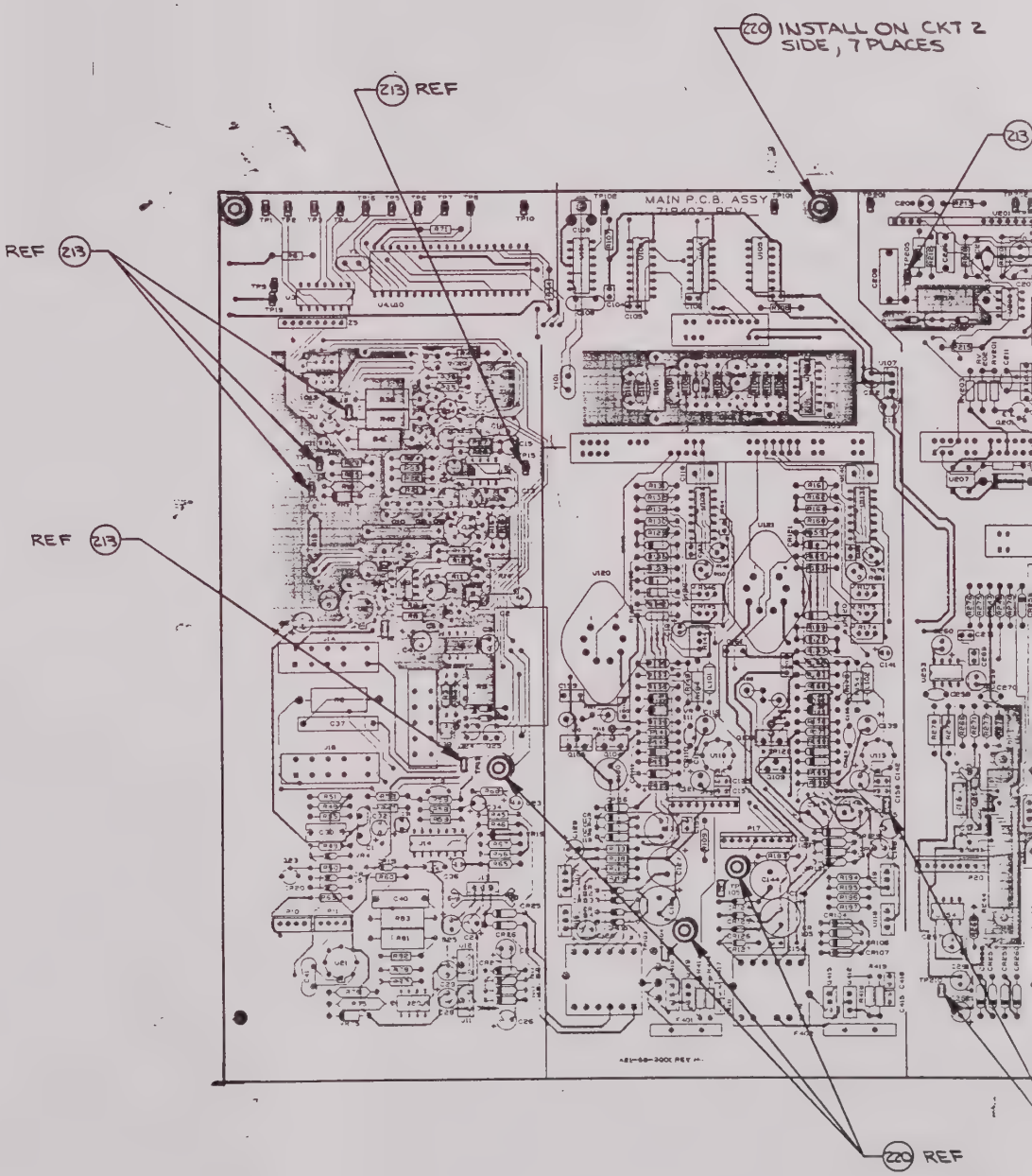
FLUKE	JOHN FLUKE MFG. CO., INC. P O BOX C9090 EVERETT, WA 98206
89536	DO NOT SCALE DRAWING

ASSEMBLY, MAIN PCB

PART NO	SIZE	DRAWING NO
718403	D	A21-50-4001
868559		A21-50-4001P

SCALE 1.5/1 SH 3 OF 4 REV J

PROPRIETARY



CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

A21-50-4001
A21-50-4001P
SH 4 OF 4 REV J

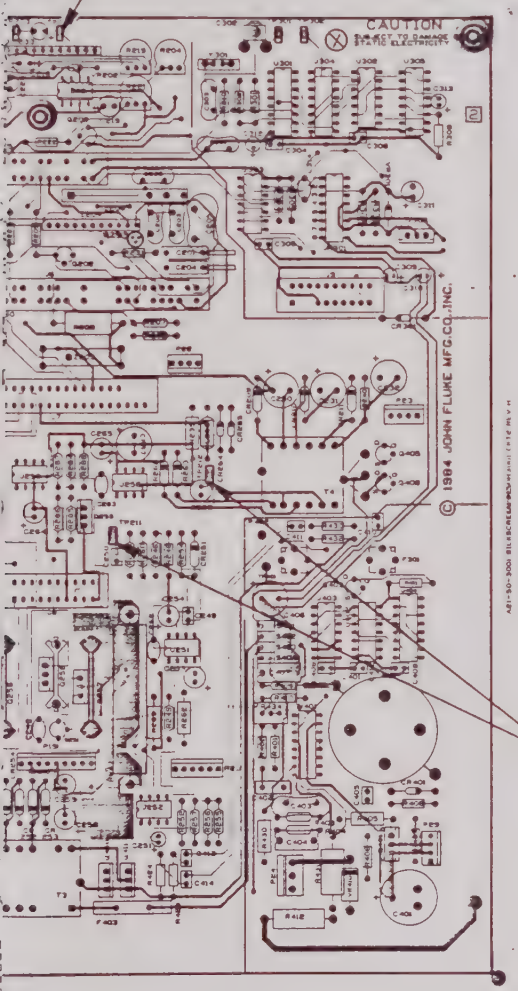
REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

(213) 37 PLACES

REF

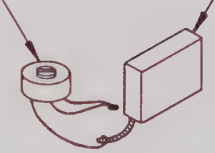


(213) REF

(213) REF

REF (60)

(127) REF



APPLY RTV 3145 (PN 953828) TO HOLD COMPONENTS TO PWB. RTV MAY TOUCH TRACES. DO NOT USE RTV 3140.

DETAIL VI
SCALE : NONE
98
56

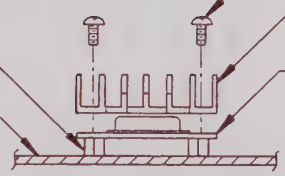
(222) 2 PL

(193)

2 PL (221)

-186

-1



DETAIL V
SCALE : 1/1
TYPICAL 2 PLACES
12

SEE SHEET 1 FOR PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

2590A	2590A-5001	717595
BASIC	A21-50-5001	716233
DWG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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FLUKE
89536

JOHN FLUKE MFG. CO., INC.
P.O. BOX C9090
EVERETT, WA 98206

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
TOLERANCE
XX = ±
XXX = ±
ANGLES = ±
DIMENSIONS IN INCHES
FINISH

DWN	D.C. BARRETT	3/23/84
CHK	A. Oberly	10-7-6
PROJ ENGR	T.L. ROBB	8/1/84
MFG ENGR	A.K. WEISS	7/27/84

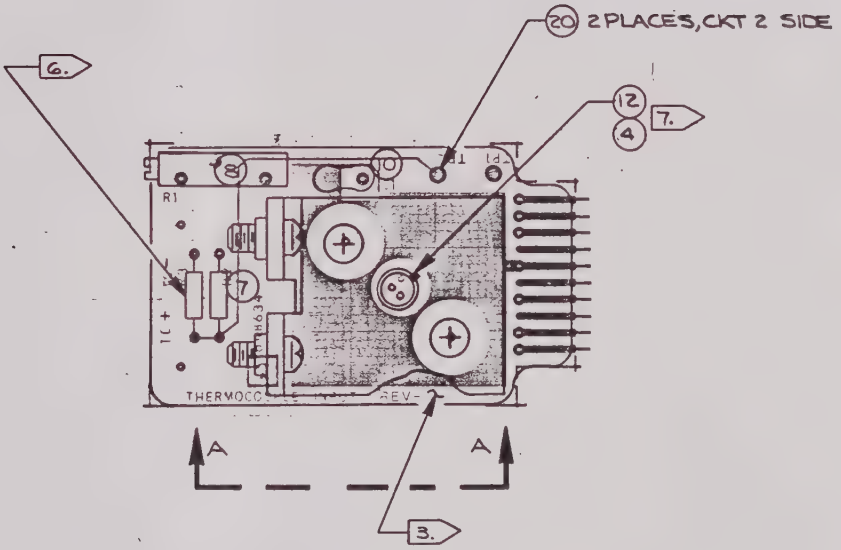
ASSEMBLY, MAIN P.C.B.

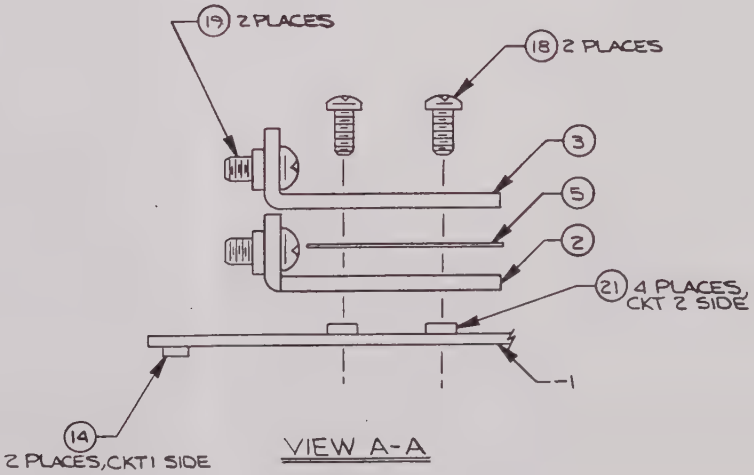
PART NO.	SIZE	DRAWING NO.
718403	D	A21-50-4001
868559		A21-50-4001P

SCALE 1 : 1 SH 4 OF 4 REV J

DIST

PROPRIETARY


20 2 PLACES, CKT 2 SIDE
6.
12
4
7.
R1
THERMOCO
REV-
A
A
3.


19 2 PLACES
18 2 PLACES
3
5
2
21 4 PLACES, CKT 2 SIDE
1
14
2 PLACES, CKT 1 SIDE

VIEW A-A

4 3 2 1

A21-44-4002 REV B SH 1 OF 1

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
—	RELEASE TO SPECIALS		DCB 9/2/82	DCB 9/2/82		
—	RELEASE TO PRODUCTION		DCB 6/13/84	JC 6/27/84	6/20/84	DCB 6/26/84
A	DCO#25263 P/N ITEM 8 WAS 330688. INCORP. DCO#23729.		DCB 4/4/86		GWS 5/2/86	DCB 5/1/86
B	DCO 38514 DEL FLAG 8		11/15/89	11/30/89	5/18/90	5/23/90

NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE A21-44-1002.
2. ASSEMBLE PER S.O.P. 111.8.
3. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INK STAMP (PERMA-DRI. 177 OR EQUIVALENT).
4. TRIM LEADS TO .05 MAX.
5. CLEAN ASSEMBLY PER S.O.P. 89.4.
6. VALUE TO BE DETERMINED IN TEST.
7. REMOVE TAB ON ITEM 12. MOUNT ITEM 4 & 12 FLUSH AGAINST P.C.B.

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES
	22				
1	21	343996		SPACER, #4-40X.07	
2	20	233411		CONNECTOR PCB	TP1,2
2	19	152165		SCREW, #6-32 X 3/8 PHP	
2	18	281196		SCREW, SEMS #4-40 X 3/8	
	17				
	16				
	15				
2	14	380196		P-NUT, #4-40	
	13				
1	12	329698		TRANSISTOR 2N2484	Q1
	11				
1	10	148478		CAP, MICA, 500V, 150PF	
	9				
1	8	268581		RES. VAR. 100K, 1/2W	R1
1	7	290122		RES. 1/8W, MF, 200.08K	R2
	6				
1	5	473561	2190A-8003	INSULATOR	
1	4	722074	A21-50-8013	INSULATOR, TO -18	
1	3	648519	A21-44-2008	POSITIVE TC INPUT	TC +
1	2	648527	A21-44-2009	NEGATIVE TC INPUT	TC -
1	1	648576	A21-44-3002	PCB, TC INPUT	A2

PARTS LIST

BASIC	A21-44	587394
DWG NO. SUFFIX	DRAWING NO	PART NO.
	FIRST USED ON APPLICATION	

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P.O. BOX 4320
MOUNTLAKE TERRACE, WA 98043

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TOLERANCE: XX = ± XXX = ± ANGLES ±
DIMENSIONS IN INCHES
FINISH

DWN	D.C. BARRETT	9/2/82
CHK	D.C. BARRETT	9/2/82
PROJ ENGR	T.L. ROBB	6/26/84
MFG ENGR	H.C. JONES	7/9/84

THERMOCOUPLE INPUT ASSY

PART NO.	SIZE	DRAWING NO.
648634	D	A21-44-4002
SCALE 2:1	SH 1 OF 1	REV B

DIST

8 7 6 5

NOTES:

1. FOR SCHEMATIC DIAGRAMS SEE A21-44-1003.
2. ASSEMBLE PER S.O.P. 111.8.
3. MARK ASSY REV LETTER IN SPACE PROVIDED USING INK STAMP PERMA DRI 177 OR EQUIV.
4. CLEAN ASSY PER S.O.P. 89.4.
5. TRIM LEADS TO .05 MAX. PER S.O.P. 89.19
6. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 15.7.
7. LCD1, LCD2, LCD3, LCD4.
8. R4, R5, R6, R101, R102, R103, R301, R302.
9. R2, R203, R204, R205.
10. C1, C101, C102, C103, C302, C303.
11. C104, C301.
12. C204, C206.
13. U202, U303.
14. U101, U301.
15. U102, U302.
16. INSTALL ITEM 2 WITH LCD CIRCUIT TRACES AGAINST ITEM 51.
17. INSTALL AFTER FLOW SOLDER AND LEAD TRIM.

17

17

17 ⊗ ⊗ ⊗ ⊗ ⊗

17 ⊗ ⊗ ⊗

17 ⊗

CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

4 | 3 | 2 | 1

A21-44-4003 REV — SHT 1 OF 2

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENG
—	RELEASE TO SPECIALS		R.M.W 4-7-82	DCB 4/7/82		
—	RELEASE TO PRODUCTION		DCB 6/21/84	DCB 6/21/84	DR 6/21/84	DCB 6/21/84

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES
8	54	494641		SCREW, S.T., #5x5/16	
	53				
	52				
4	51	453092		CONN, ELASTROMERIC	
4	50	429282		SOCKET, IC, 40 PIN	
	49				
	48				
1	47	447615		CRYSTAL, 3.84MHz	Y201
	46				
1	45	429100		IC, A/D CONVERTER	U201
1	44	355172		IC, DIGITAL 4001	U105
1	43	507376		IC, DIGITAL 4056	U104
1	42	536441		IC, DIGITAL 74LS160	U103
2	41	340117		IC, DIGITAL 4013B	15
2	40	643106		IC, DIGITAL ICM7224	14
2	39	355222		IC, DIGITAL 4030	13
1	38	404681		IC, DIGITAL 4069	U2
1	37	643114		IC, DIGITAL MD4332B	U1
	36				
1	35	213396		TRANSISTOR, NPN, 2N3904	Q201
	34				
	33				
1	32	203323		DIODE, SILICONE IN4448	CR101
	31				
	30				
	29				
1	28	105692		CAP, CER, 500V, 500pF	C208
1	27	143429		CAP, MICA, 500V, 470pF	C203
1	26	436113		CAP, MYLAR, 100V, .22uF	C202
1	25	446781		CAP, POLY, .10uF	C201
2	24	446773		CAP, POLY, .047uF	12
2	23	175224		CAP, MICA, 500V, 12pF	11
1	22	407361		CAP, CER, 100V, .01uF	C105
1	21	234484		CAP, MYLAR, 250V, .022uF	C2
6	20	519157		CAP, CER, 50V, .22uF	10
	19				
	18				
	17				
1	16	343426		RES., DC, 1/4W, 5%, 1K	R105
1	15	109793		RES, C.C., 1W, 5%, 1M	R202
1	14	348953		RES, DC, 1/4W, 5%, 220K	R201
1	13	348987		RES, DC, 1/4W, 5%, 1M	R104
4	12	348920		RES, DC, 1/4W, 5%, 100K	9
2	11	441485		RES, DC, 1/4W, 5%, 200K	R1,R3
8	10	348339		RES, DC, 1/4W, 5%, 10K	8
	9				
	8				
	7				
	6				
	5				
17 4	4	479642	8010A-2009	BEZEL, LCD	
17 4	3	471730	3010A-2008	BRACKET, LCD	
17 4	2	723197		LCD, 5 DIGIT	7
1	1	643584	A21-44-3003	PCB DISPLAY ASSY	

PARTS LIST

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89536

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UNLESS OTHERWISE SPECIFIED
TOLERANCE
XX = ±
XXX = ±
ANGLES = ±
DIMENSIONS IN INCHES
x_c =

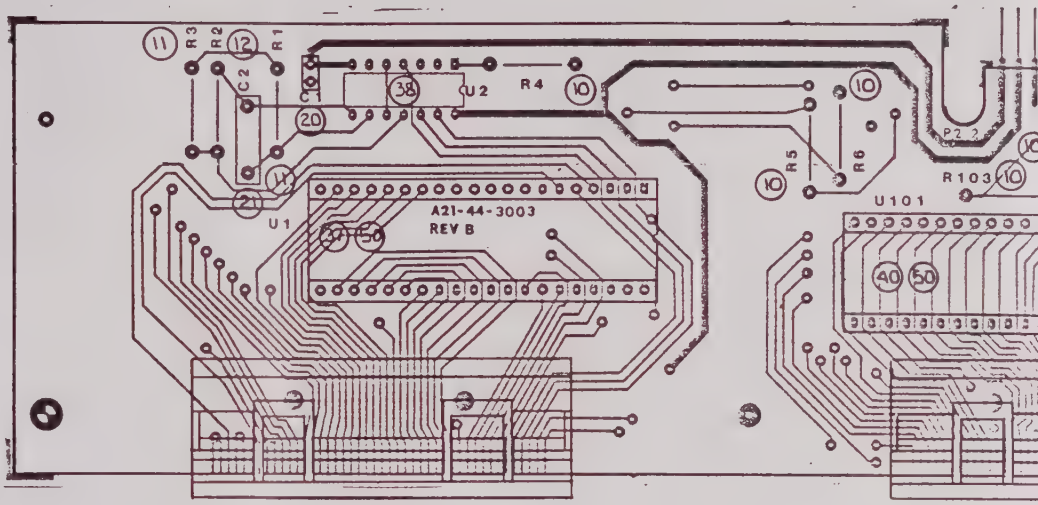
DWN	R. G. WAGONBLAST	4-5-82
CHK	D. C. BARRETT	4/7/82
PROJ ENGR	T. L. ROBB	6/26/84
MFG ENGR	D. K. WEISS	7/1/84
FINISH		

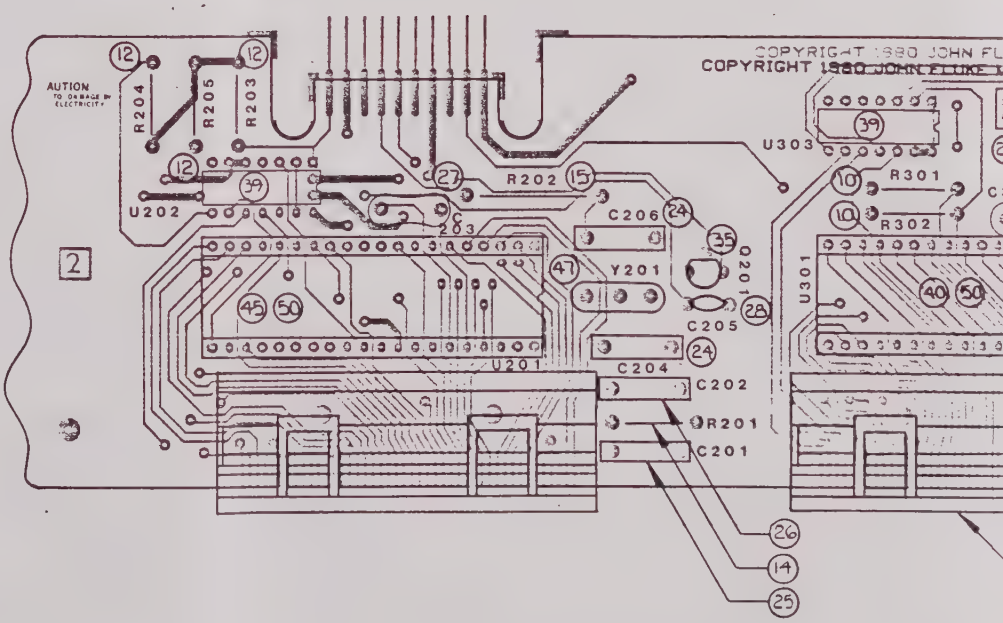
DISPLAY PCB ASSY

BASIC	A21-44	587394
DWG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

PART NO.	SIZE	DRAWING NO
648642	D	A21-44-4003
SCALE 2/1	SH 1 OF 2	REV —

DIST





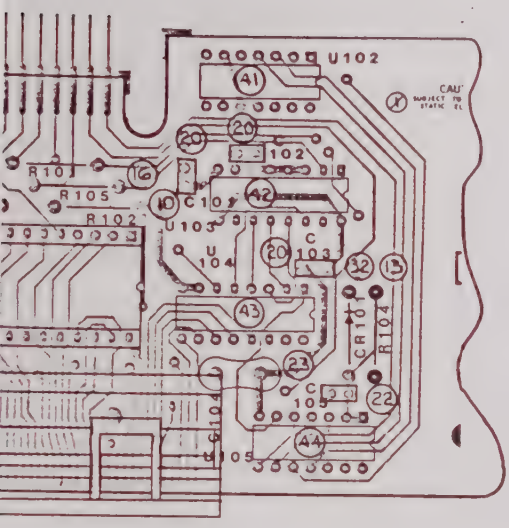
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

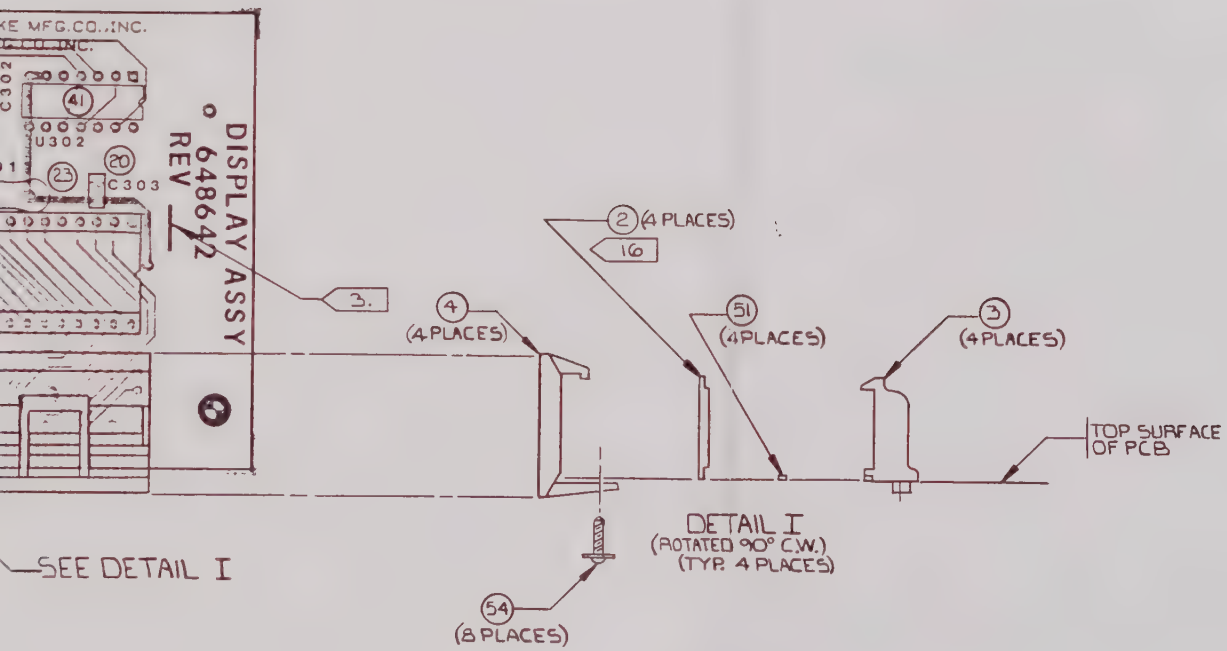
4 3 2 1

REVISIONS							
LTR	DESCRIPTION	EFF	APPROVAL / DATE				
			DWN	CHK	PROJ ENGR	MFG ENG

SEE SHEET1FOR REV.

A21-44-4003 REV — SH 2 OF 2





SEE SHEET 1 FOR NOTES AND PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

BASIC	A21-44	587394
DWG NO. SUFFIX	DRAWING NO.	PART NO.
	FIRST USED ON	
	APPLICATION	

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DIMENSIONS IN INCHES x_c =

DWN	R.G. WAGONBLAST	4-5-82
CHK	D.C. BARRETT	4/7/82
PROJ ENGR		
MFG ENGR		
FINISH		

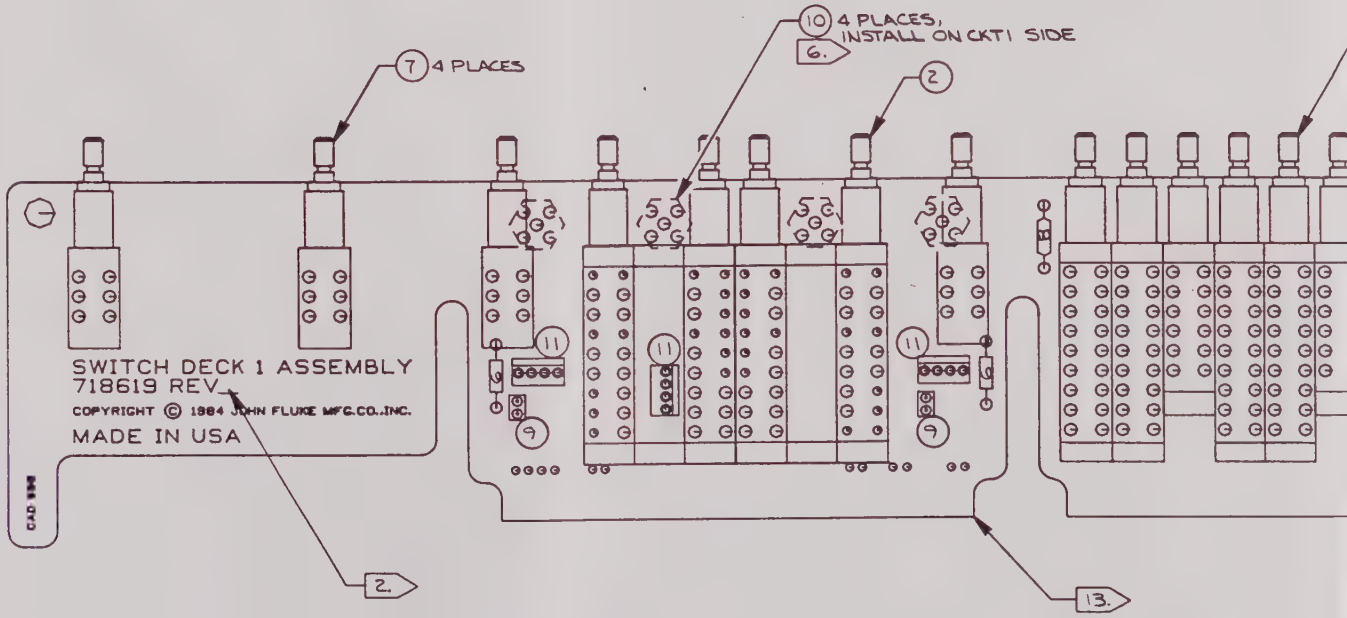
DISPLAY P.C.B. ASSY

PART NO.	SIZE	DRAWING NO.
648642	D	A21-44-4003
SCALE 2-1	SH 2 OF 2	REV —

DIST

NOTES: UNLESS OTHERWISE SPECIFIED

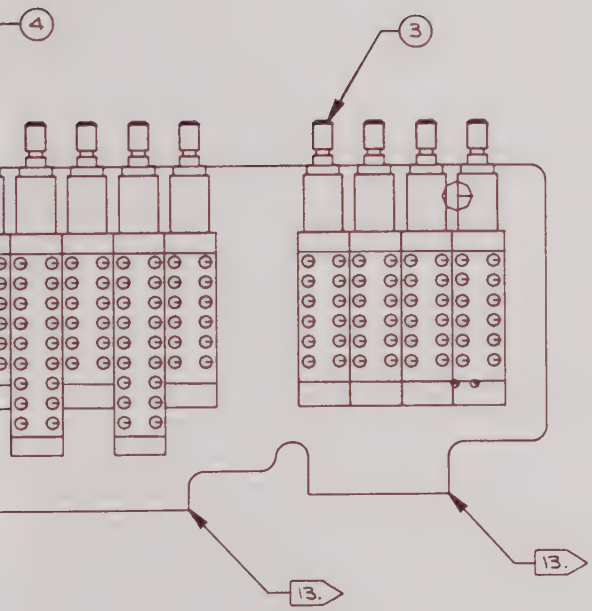
1. FOR SCHEMATIC DIAGRAM SEE A21-50-1001.
2. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INK STAMP (PERMA-DRI 177 OR EQUIVALENT).
3. ASSEMBLE PER S.O.P. 111.8.
4. CLEAN ASSEMBLY PER S.O.P. 89.4.
5. LEADS TO BE .100" LG MAX.
6. TRIM LEADS FLUSH TO P.C.B. WHERE INDICATED.
7. REMOVE ASSEMBLIES FROM CARRIER AFTER FLOW SOLDER. CUT TABS FLUSH TO OR BELOW P.C.B. EDGE.
8. R112, R192
9. S1, S2, S3, S10.
10. C110, C153
11. P12, P14, P15, P18.
12. P27, P28, P30.
13. BEVEL EDGE FINGERS, .02" MAX.



4	3	2	1

A21-50-4004 SH 1 OF 1 REV —

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
—	RELEASE TO PRODUCTION		DCB 7/2/84	8/5/84	7/18/84	7/19/84



QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES
	17				
	16				
	15				
8	14	285353		SPACER, SWITCH	
	13				
	12				
3	11	631184		CONN.,POST HEADER,4 POS	12
4	10	352450		CONNECTOR, BNC	11
2	9	519157		CAP.,CERAM,50V,.22uF	10
1	8	474445		RES.,MF,1/8W,5%,1K	R203
4	7	520437		SWITCH, DPDT, PUSH-PUSH	9
2	6	188417		RES.,CC,1/4W,5%,3.9M	8
	5				
1	4	473322	8010A-8006	SWITCH ASSEMBLY	S11-20
1	3	729483	A21-50-8002	SWITCH,RELAY TIMER	S22-25
1	2	729467	A21-50-8001	SWITCH, FREQ SIGNAL SELECT	S5-8
1	1	718585	A21-50-3004	P.C.B., SWITCH DECK 1	

PARTS LIST

ESBOA	ESBOA-5004	717585
BASIC	A21-50-5001	716233
OWG NO SUFFIX	DRAWING NO	PART NO.
	FIRST USED ON	
	APPLICATION	

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DIMENSIONS IN INCHES: X = ± .XX = ± .XXX = ±
FINISH

DWN	D.C. BARRETT	3/2/84
CHK		8/5/84
PROJ ENGR	T.L. ROBB	7/18/84
MFG ENGR	A.K. WILLIS	7/19/84

ASSEMBLY, SWITCH DECK #1

PART NO.	SIZE	DRAWING NO
718619	D	A21-50-4004
SCALE 1.5:1	SH 1 OF 1	REV —

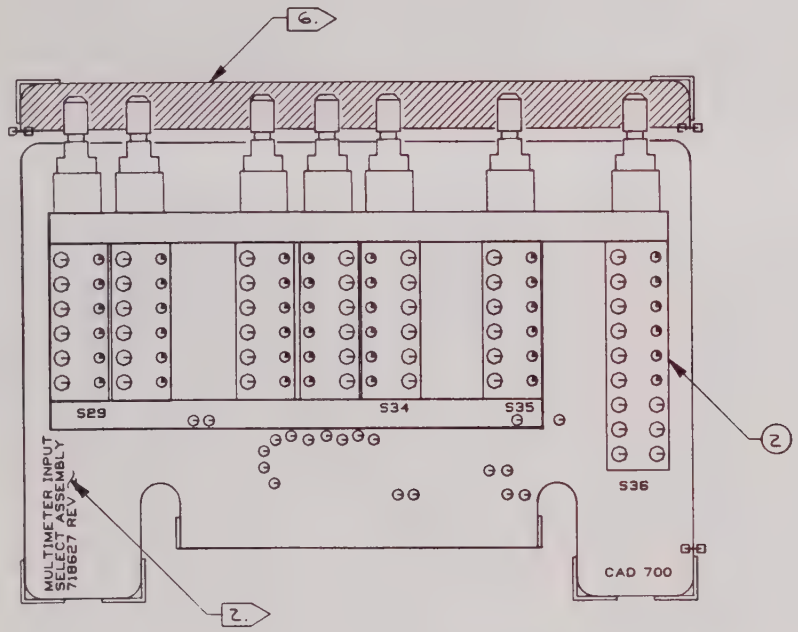
PROPRIETARY

DIST

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENG
—	RELEASE TO PRODUCTION		DCB 6/14/84	5/15/84	DR 7/10/84	7/16/84

NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE A21-50-1001
2. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INK STAMP (PERMA-DRI-177 OR EQUIVALENT).
3. ASSEMBLE PER S.O.P. 111.8
4. CLEAN ASSEMBLY PER S.O.P. 89.4.
5. LEADS TO BE .100 LG MAX.
6. REMOVE THIS AREA AFTER FLOW SOLDER. CUT TABS FLUSH OR BELOW P.C.B. EDGE.
7. S29-S36.



A21-50-4005
SH 1 OF 1 REV —

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES
1	2	729475	A21-50-8004	SWITCH, MULTI. INPUT	7.
1	1	718593	A21-50-3005	P.C.B., SWITCH DECK #2	

PARTS LIST

2580A	2580A-5001	717585
BASIC	A21-50-5001	716233
DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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DIMENSIONS IN INCHES
FINISH

DWN	D.C. BARRETT	3/30/84
CHK		5/15/84
PROJ ENGR	T.L. ROSS	7/10/84
MFG ENGR		7/11/84

ASSEMBLY, MULTIMETER INPUT SELECT

PART NO	SIZE	DRAWING NO
718627	C	A21-50-4005
SCALE 2:1	SH 1 OF 1	REV —

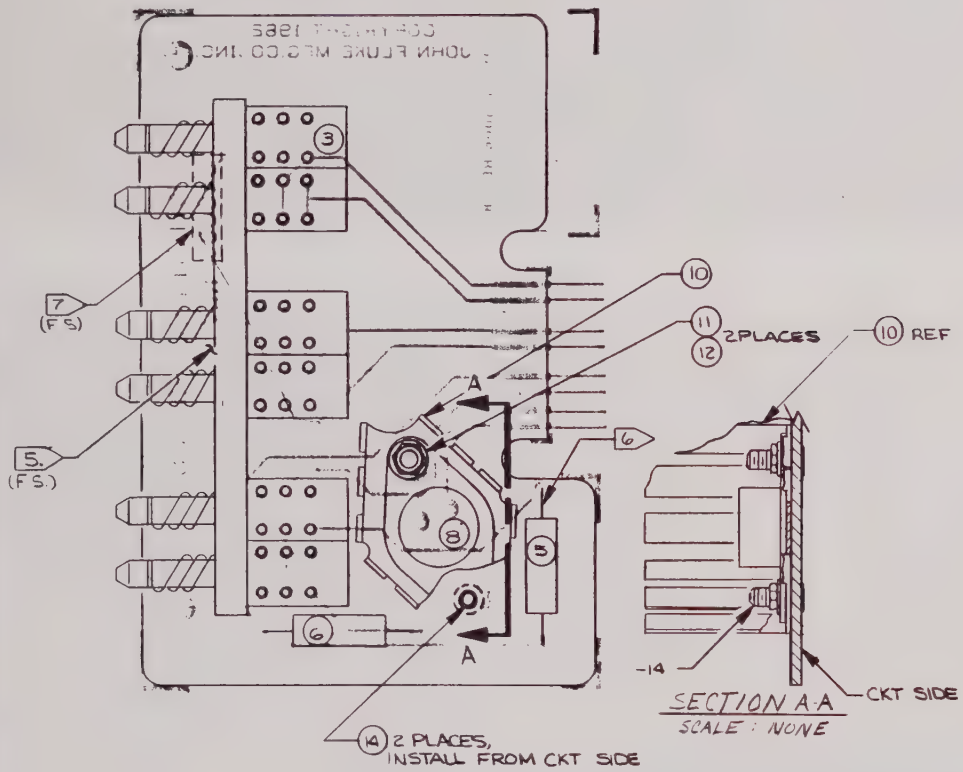
DIST

FORM A450C REV I

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENG
—	RELEASE TO SPECIALS		R.G.W 4-1-82	DCB 4/1/82		
-	RELEASE TO PRODUCTION		DCB 6/1/84	AJC 4/27/84	6/26/84	DCB 6/26/84
A	DCO 38514 ADDED FLAGS 6 & 7		11/14/89	AJC 5/17/90	5/17/90	DCB 5/12/90

NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE A21-44-1001.
2. ASSEMBLE PER S.O.P. 111.3.
3. CLEAN ASSEMBLY PER S.O.P. 89.4.
4. TRIM LEADS TO .10 MAX.
5. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INK STAMP (PERMA-DRI, 177 OR EQUIVALENT).
6. TRIM LEAD INDICATED OF ITEM 5 AS CLOSE TO PCB AS POSSIBLE
7. COVER EXISTING PART NO (648683) WITH TYPED LABEL READING: 648675



SECTION A-A
SCALE : NONE

A21-44-4006
SH 1 OF 1 REV A

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES
2	14	603894		STUD, THREADED	
	13				
2	12	110403		LOCKWASHER, #4 INT	
2	11	110635		NUT #4-40	
1	10	631317		HEATSINK, TO66	
	9				
1	8	385302		TRANSISTOR, 2N4240	Q256
	7				
1	6	151043		RESISTOR 1/2W, MF, 10Ω	R283
1	5	151324		RESISTOR 1/2W, MF, 1KΩ	R282
	4				
1	3	634352	A21-44-8005	SWITCH, RANGE SELECT	S37-42
	2				
1	1	648618	A21-44-3006	PCB, RANGE SELECT	A6

PARTS LIST

BASIC	A21-44	587394
DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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XX = ±
XXX = ±
ANGLES = ±
DIMENSIONS IN INCHES
X_C =
FINISH

DWN	S. PETERSON	6/28/81
CHK	D.C. BARRETT	4/1/82
PROJ ENGR	T.L. ROSS	6/26/84
MFG ENGR		7/5/84

RANGE SELECT SWITCH DECK ASSY

PART NO.	SIZE	DRAWING NO
648675	C	A21-44-4006
SCALE 2:1	SH 1 OF 1	REV A

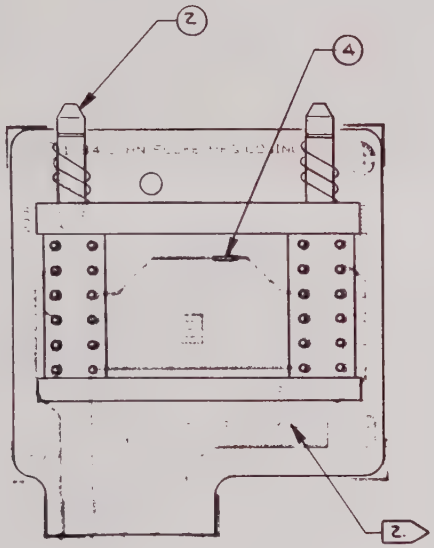
DIST

FORM A486C REV I

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR
-	RELEASE TO PRODUCTION		SCB 6/13/84	JB 6/18/84	JJR 7/18/84	TLR 7/18/84

NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE A21-50-1001.
2. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INKSTAMP (PERMA-DRI 177 OR EQUIVALENT).
3. ASSEMBLE PER S.O.P. 111.8.
4. CLEAN ASSEMBLY PER S.O.P. 89.4.
5. LEADS TO BE .100 LONG MAX.



A21-50-4008
SH 1 OF 1 REV —

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES
	7				
	6				
	5				
1	4	512889		TEST POINT	
	3				
1	2	634337	A21-44-8003	SWITCH, T/C SELECT	526,27
1	1	734897	A21-50-3008	P.C.B., T/C SELECT	

PARTS LIST

2590FT3	2590A-5001	717595
BASIC	A21-50-5001	716233
DWG NO SUFFIX	DRAWING NO FIRST USED ON	PART NO.
APPLICATION		

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DIMENSIONS IN INCHES
FINISH

DWN	D.C. BARRETT	4/13/84
CHK		6/14/84
PROJ ENGR	T.L. ROBB	7/18/84
MFG ENGR	A.K. JONES	7/18/84

ASSEMBLY, THERMO-COUPLE SELECT P.C.B.

PART NO.	SIZE	DRAWING NO
734889	C	A21-50-4008
SCALE 2X	SH 1 OF 1	REV —

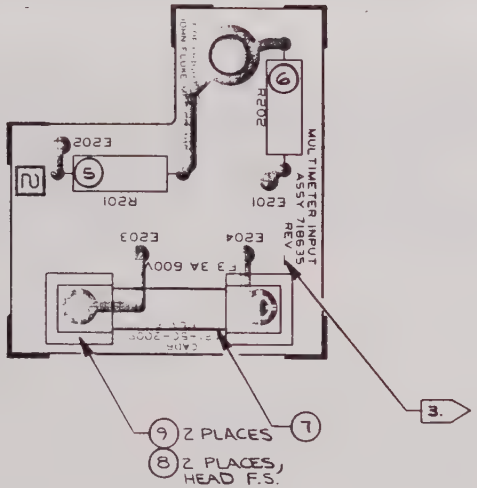
PROPRIETARY

JF FORM A450C Rev 7.82

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
A	P/N ITEM 9 WAS 516880. RE-DESIGNED P.C.B., ITEM 1.		DCB 6/13/84			
–	RELEASE TO PRODUCTION		DCB 6/14/84	JP 8/15/84	JRR 7/18/84	[illegible] 7/19/84

NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE A21-50-1001.
2. ASSEMBLE PER S.O.P. 111.8.
3. MARK ASSEMBLY REVISION LETTER IN SPACE PROVIDED USING INK STAMP, PERMA-DRI 177 OR EQUIVALENT.
4. CLEAN ASSEMBLY PER S.O.P. 89.4.
5. DO NOT REMOVE P.C.B.'S FROM CARRIER.



A21-50-4009
SH 1 OF 1 | REV A

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES
	12				
	11				
	10				
2	9	103028		FUSE HOLDER	
2	8	103424		RIVET	
1	7	475004		FUSE,600V,3A,FAST	F3
1	6	474080		RES.,WW, 2W,10%,1K	R202
1	5	109397		RES.,CC, 1W,10%,100K	R201
	4				
	3				
	2				
1	1	718601	A21-50-3009	P.C.B.,MULTIMETER INPUT	

PARTS LIST

2590A	2590A-5001	717595
BASIC	A21 50 5001	716233
DWG NO SUFFIX	DRAWING NO	PART NO.
	FIRST USED ON	
	APPLICATION	

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DIMENSIONS IN INCHES
FINISH

DWN	D.C. BARRETT	5/6/84
CHK	JP	8/9/84
PROJ ENGR	J.L. Robb	
MFG ENGR	A k Jr. ss	7/18/84

ASSY, MULTIMETER INPUT P.C.B.

PART NO.	SIZE	DRAWING NO
718635	C	A21-50-4009
SCALE 2x	SH 1 OF 1	REV A

PROPRIETARY
DIST

F FORM A450C Rev 2 82

NOTES: UNLESS OTHERWISE SPECIFIED

101. FOR WIRE DIAGRAM SEE A21-50-1301.

102. FOR SCHEMATIC DIAGRAM SEE A21-50-1001.

103. ASSEMBLE PER S.O.P. 111.8.

104.

105. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1

106. R79, R151, R181, R264, R280, R289.

107. R152, R182.

108. R153/S43, R183/S44.

109. R80, R265, R281, R290.

110. R150, R180

CAUTION
SUBJECT TO DAMAG
STATIC ELECTRI

5	180	631606		WASHER, FLAT, #8, BRASS	
2	179	631614		NUT, 8-32, BRASS	
3	178	823211	5725A-2038	REAR INSULATOR	
3	177	823187	5725A-2033	FRONT INSULATOR	
2	176	850292	5725A-2703-01	RED BINDING POST	
1	175	850297	5725A-2703-02	BLACK BINDING POST	
	174				
	173				
	172				
4	171	745943		WASHER, FLAT, NYLON, 3/8"	
	170				
10	169	745877		ISOLATING WASHER	
	168				
1	167	177022		SCREW, #6-32X3/8", SEMS	
1	166	228890		SCREW, #8-32X1/4", PHP	
1	165	721076		SPACER, BRASS, #8-32X1/2"	
1	164	403253		SPACER, NYLON, #6-32X7/8"	
	163				
12	162	407908		ANCHOR, CABLE TIE	
34	161	172080		CABLE TIE, 4" LG.	
	160				
	159				
.29"	158	196683		HEATSHRINK, 1/2" I.D	
	157				
.50"	156	149450		HEATSHRINK, #14	
	155				
	154				
	153				
	152				
	151				
	150				
	149				
	148				
	147				
	146				
	145				
	144				
2	143	110510		HEX NUT, 3/8" - 32	
8	142	195255		HEX NUT, KEPS, #4-40	
2	141	110601		HEX NUT, 1/4" - 32	
1	140	110320		LOCKWASHER, INT, #8	
4	139	129957		LOCKWASHER, INT, 3/8"	
2	138	110817		LOCKWASHER, INT, 1/4"	
1	137	631291		WASHER, NON-TURN, 3/8"	
1	136	644021		CONN., BAYONET, 3 PIN	
1	135	643809		CONN., BAYONET, 4 PIN	
	134				
	133				
	132				
3	131	152033		CONN., BNC	
	130				
	129				
2	128	460239		FUSE HOLDER, CAP	

2	127	450529		FUSE HOLDER, BODY	
1	126	109173		FUSE, 250V, 2A, FA	F2
1	125	109199		FUSE, 250V, 3A, FA	F1
1	124	615054		SWITCH, ROCKER, DPDT	S45
	123				
	122				
	121				
1	120	723809		L.E.D., GREEN	DS22
2	119	734905		RF CABLE ASSY, 17IN.	
2	118	438226		RF CABLE ASSY, 15IN	
1	117	733782		RES. VARI, CERMET, 1T, 250K	R114
2	116	682914		RES., VARI, WW, 10T, 200Ω	R10
4	115	682922		RES., VARI, WW, 10T, 1K	R9
2	114	631457		RES., VARI, W/SWITCH, 100K	R8
2	113	682948		RES., VARI, W.W., 10T, 100K	R7
6	112	682930		RES., VARI, WW, 10T, 10K	R1
1	111	734913	A21-50-4405	THRESHOLD ADJUST CABLE	
	110				
	109				
4	108	341404	MOO-200-708	POINTER KNOB ASSY	
14	107	341396	MOO-200-707	KNOB ASSY	
1	106	718635	A21-50-4009	MULTIMETER INPUT ASSY	
1	105	884770	A21-44-4406	CABLE SET, FRONT PNL	
1	104	634741	A21-44-8008	SWITCH, TAC TYPE SELECT	S46
2	103	551414	A21-44-4404	AMPLITUDE ADJUST CABLE	
2	102	555480	A21-44-2011	BUSHING, SWITCH	
1	101	723254	A21-50-8101	FRONT PANEL	
QTY	ITEM	PART NO	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR
A	SHT 1-4: ITEM 101 WAS 722447, DEL. ITEM 105. ADDED ITEM 118, 119, 129 & 168-171. QTY ITEM 165 WAS 7. QTY ITEM 139 WAS 1. P/N ITEM 131 WAS 384888. ADDED DETAIL II & III. SHT 6: P/N ITEM 238 WAS 195255. P/N ITEM 239 WAS 485417. QTY ITEM 236 WAS 5.	DCO 7/30/84			AC 5/18/84	
B	REV'D PER DCO'S: 21493, 22237, & 22754.	DCO 7/30/84			AC 6/19/84	
C	REV'D PER DCO'S: 36792, 38514, & 38773	7/13/89			AC 6/19/89	
—	RELEASE TO PRODUCTION				AC 6/19/89	

REVISIONS

A21-50 SHT 1 OF 9 REV C

BASIC DWG NO SUFFIX	DRAWING NO	PART NO		
APPLICATION	FIRST USED ON			

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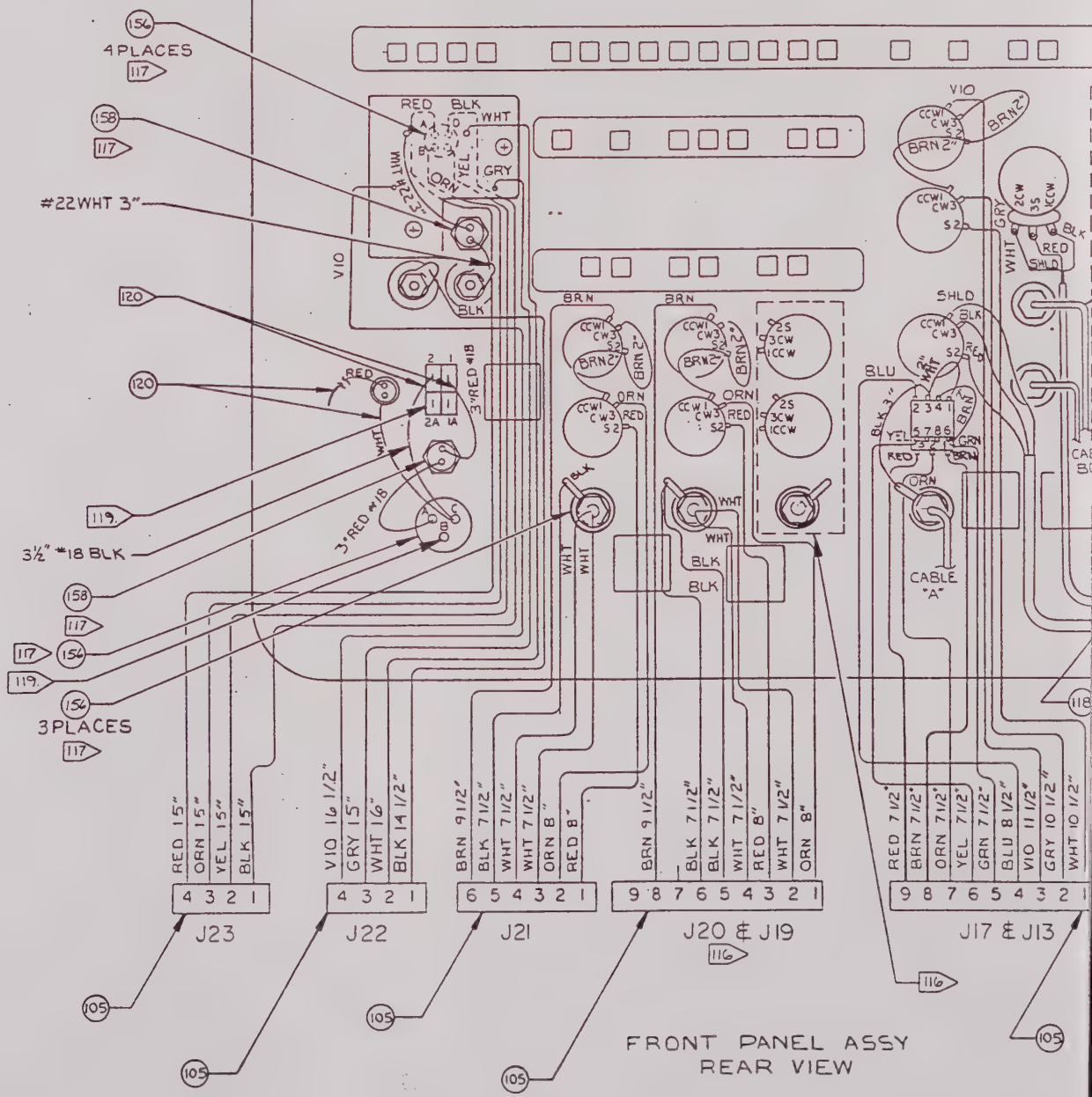
TOLERANCE
.XX ± .1
.XXX ± .01
ANGLES ± 1°
DIMENSIONS IN INCHES

DWN	D.C. BARRETT	8/21/84
CHK		8/31/84
PROJ ENGR	T.L. ROSE	9/1/84
MFG ENGR	A.R. WEISS	7/31/84
APPR		

A21-50 TEST & BUTTON UP (GROUP 01)

PART NO	SIZE	DRAWING NO
708941	D	A21-50
SCALE —	SH 1 OF 9	REV C

PROPRIETARY



CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR
~	SEE SHEET 1 FOR REV					

A21-50 REV C SH 4 OF 9

SEE DETAIL VII (14 PLACES)

(119) (2 PLACES)

SEE DETAIL VI (2 PLACES)

NOTES: (CONT'D FROM SHEET 1)

(115) WIRE AS SHOWN FOR J17

(116) WIRE AS SHOWN FOR J20

(117) SLEEVE SOLDER CONNECTIONS INDICATED WITH HEATSHRINK. CUT HEATSHRINK TO NECESSARY LENGTH.

(118) INSTALL AS REQUIRED ON GROUPS -01 & -02.

(119) INSTALLATION OF PARTS OF ITEM 215 (GRP-02) IS PERMISSIBLE AT THIS LEVEL. SEE SHEET 8 FOR CORRECT INSTALLATION.

(120) CONNECTOR FASTON ON THIS END.

(114) (2 PLACES)

BOTTOM VIEW

TOP VIEW

DETAIL VI
NO SCALE

(112) (6 PLACES)
(113) (2 PLACES)
(114) (4 PLACES)
(116) (2 PLACES)

DETAIL VII
NO SCALE

(162) 6 PLACES

CABLE A

)2 PL

(115)

RED BLK SHLD — 4 3 2 1 — J28 & J27

BLU BLU RED — 4 3 2 1 — J30

ORN 6.5 YEL 7 RED 7 BLU 7 1/2" — 4 3 2 1 — J11

BLK 7" BLU 7" VIO 7" GRN 7" — 4 3 2 1 — J10

(115)

(103) (111) (105) (105)

SEE SHEET 1 FOR PARTS LIST AND NOTES

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

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DIMENSIONS IN INCHES

DWN	B. HANSON	4-10-84
CHK	A. Cooper	10-3-84
PROJ ENGR	T. L. ROSS	9/1/84
MFG ENGR	A. K. WEISS	9/1/84
FINISH		

A21-50 TEST & BUTTON UP (GROUP 01)

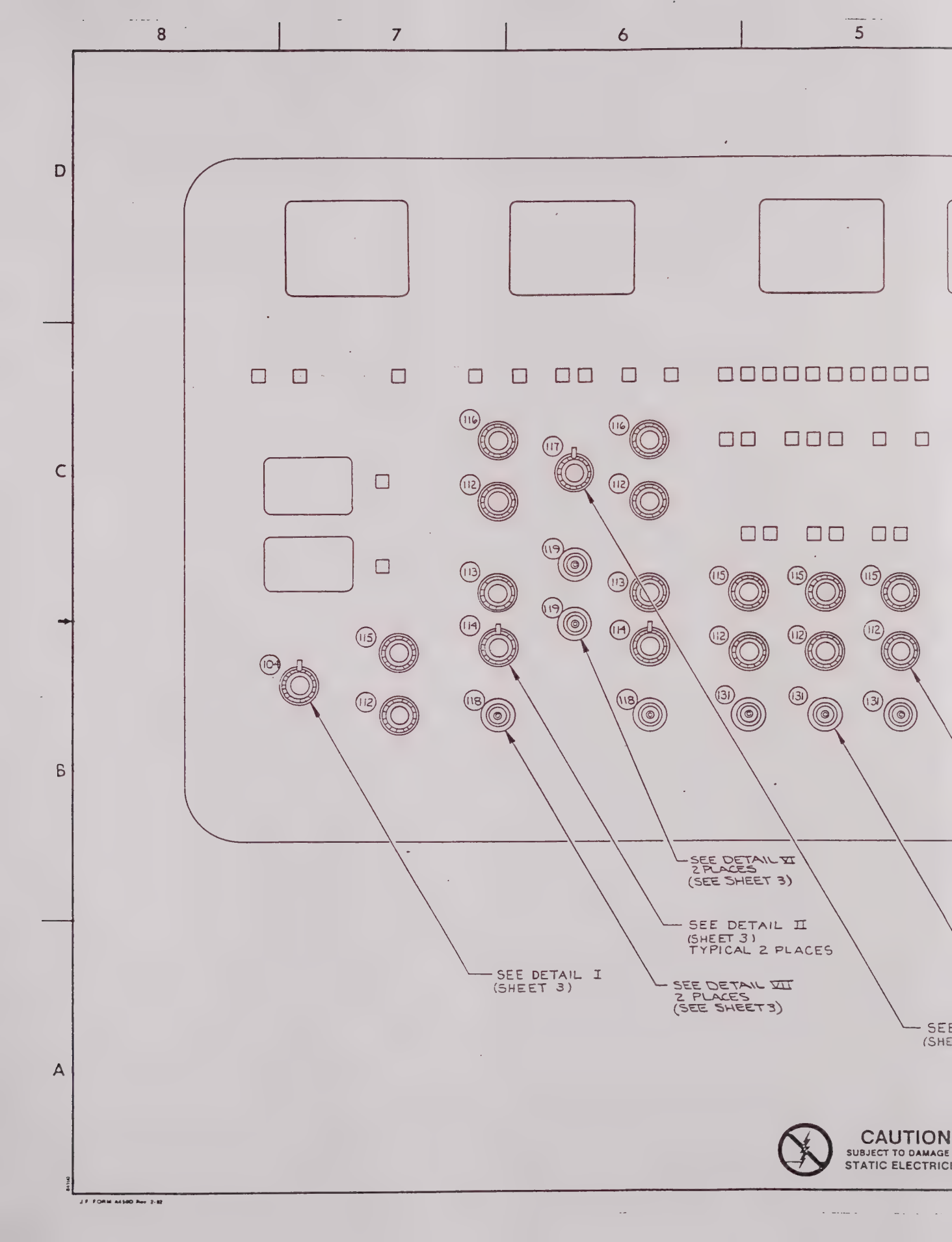
PART NO.	SIZE	DRAWING NO
708941	D	A21-50

SCALE 1:1 SH 4 OF 9 REV C

BASIC DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

PROPRIETARY

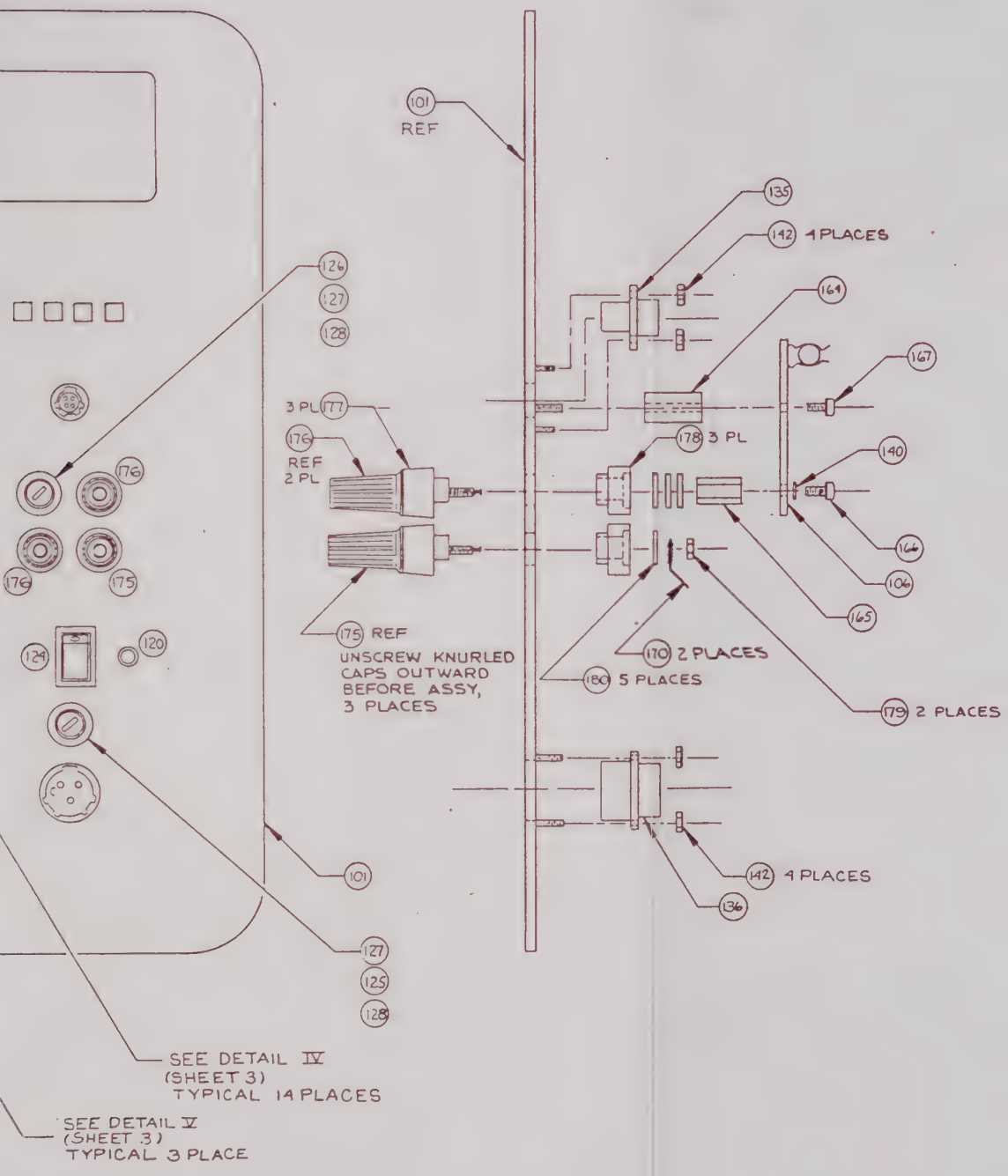
D-87


8
7
6
5
D
C
B
A
SEE DETAIL VI
2 PLACES
(SEE SHEET 3)
SEE DETAIL II
(SHEET 3)
TYPICAL 2 PLACES
SEE DETAIL I
(SHEET 3)
SEE DETAIL VII
2 PLACES
(SEE SHEET 3)
CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI

REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR

A21-50 SH 2 OF 9 REV C

SEE SHEET 1 FOR REVISIONS



DETAIL III
(SHEET 3)

SEE SHEET 1 FOR PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

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BASIC DWG NO SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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XX = ±
XXX = ±
ANGLES = ±
DIMENSIONS IN INCHES
x_c =

DWN	B. HANSON	4-17-84
CHK	A. Coberly	10-27-86
PROJ ENGR	T. L. ROBB	8/1/84
MFG ENGR	A. K. WEISS	7/31/84

FINISH

A21-50 TEST & BUTTON UP (GROUP 01)

PART NO.	SIZE	DRAWING NO.
708941	D	A21-50
SCALE 1:1	SH 2 OF 9	REV C

PROPRIETARY

DIST

8 7 6 5

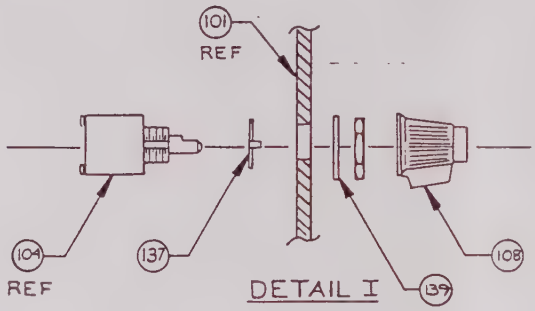
D C B A

INSTRUCTIONS:

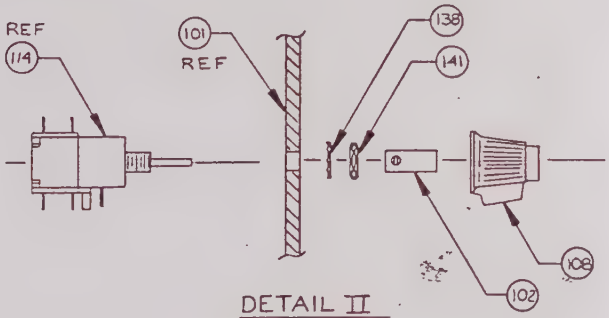
AFTER (104) IS INSTALLED, TURN SWITCH ALL THE WAY CCW. THEN INSTALL (108) SO POINTER IS IN THE "J" POSITION.

INSTRUCTIONS:

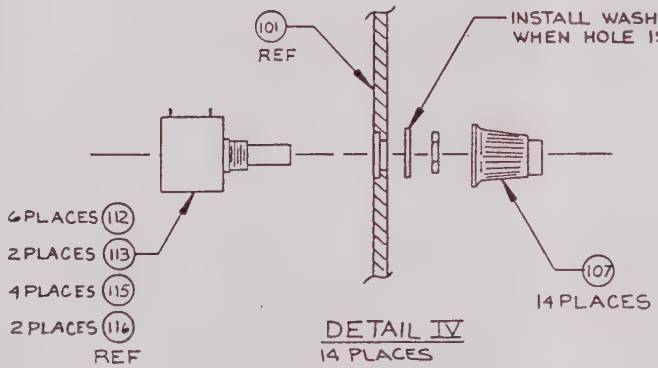
REMOVE ONE SET SCREW FROM (108) AND LOOSEN THE SECOND SET SCREW. SLIP (102) INTO (108) AND ALIGN SUCH THAT THE SET SCREW HOLE IN (102) MATCHES THE EMPTY SET SCREW HOLE IN (108). SECURE BY TIGHTENING THE SECOND SET SCREW IN (108). PLACE (108) AND (102) OVER THE SHAFT OF (114) AND SECURE THE ASSEMBLY BY REINSTALLING AND TIGHTENING THE FIRST SET SCREW.



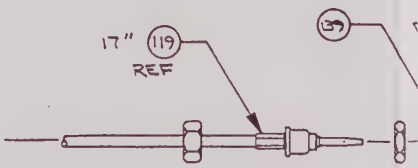
DETAIL I



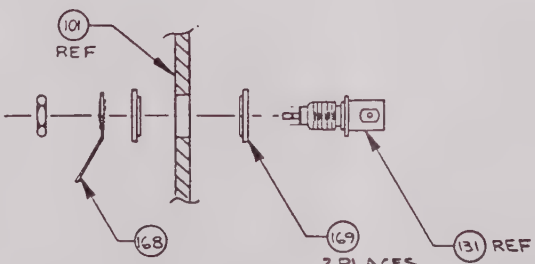
DETAIL II
2 PLACES



DETAIL IV
14 PLACES

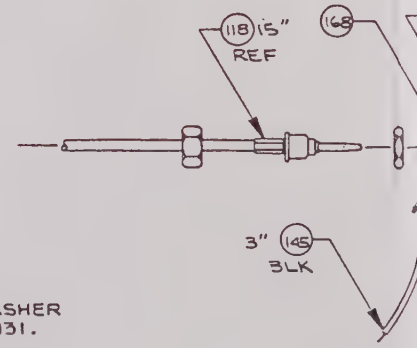


DETAI
2 PLA



DETAIL V
3 PLACES

DISCARD THE LOCKWASHER SUPPLIED WITH ITEM 131.



DETAIL
2 PLACE

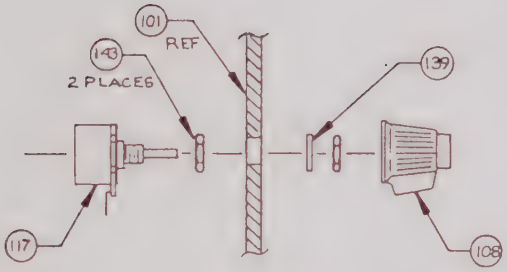
CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI

REVISIONS

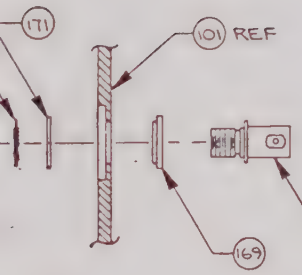
LTR	DESCRIPTION	EFF	APPROVAL / DATE OWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

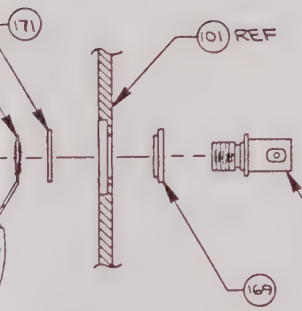
A21-50 SH 3 OF 9 REV C



DETAIL III



DISCARD THE LOCKWASHER SUPPLIED WITH ITEM 119.



DISCARD THE LOCKWASHER SUPPLIED WITH ITEM 118.

SEE SHEET 1 FOR PARTS LIST

PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

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BASIC DWG NO. SUFFIX	DRAWING NO	PART NO.
APPLICATION	FIRST USED ON	

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89536

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.XX = ±
.XXX = ±
ANGLES = ±
DIMENSIONS IN INCHES
FINISH

DWN	B. HANSON	4-30-54
CHK	A. Caprili	10-27-54
PROJ ENGR	T. L. ROOB	8/11/54
MFG ENGR	A. K. WEISS	7/31/54

A21-50 TEST & BUTTON UP
(GROUP Ø1)

PART NO.	SIZE	DRAWING NO.
708941	D	A21-50

SCALE 1-1 SH 3 OF 9 REV C

PROPRIETARY

8 7 6 5

D C B A

NOTES: UNLESS OTHERWISE SPECIFIED

201. ASSEMBLE PER S.O.P. 111.8.

202. INSTALL ITEM 249 USING GASKET CEMENT, 3M#847 OR EQUIVALENT.

203. CUT JUMPERS AS SHOWN FOR "JR301".

204. PROGRAM ITEM 221 PER DRAWING A21-50-4502T.

205. CONNECT ALL WIRES AND CABLING PER SHEET 8.

206. **WARNING:** ⓝ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1

207. ATTACH ADHESIVE SIDE OF ITEM 223 TO ITEM 216 PRIOR TO INSTALLATION OF ITEM 216. INSTALL BOTTOM SHIELD DURING FINAL TEST.

208. SLEEVE SOLDER CONNECTIONS INDICATED WITH HEATSHRINK, ITEM 248. CUT HEATSHRINK TO NECESSARY LENGTH.

CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRICI

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

A21-50 SHEET 9 REV C

1	254	166322		BRACKET, ANGLE	
1	253	333989		WASHER, FIBER, #10	
1	252	235043		SHOULDER WASHER, NYLON	
31	251	425900	8040A-2001-1	BUTTON, FUNCTION SWITCH	
5	250	426759	8040A-2001-2	BUTTON, RANGE SWITCH	
2	249	100073		GROMMET, RUBBER	
.16FT	248	113852		HEATSHRINK	
	247				
	246				
	245				
10	244	110270		WASHER, FLAT, #6	
3	243	110288		WASHER, FLAT, #8	
6	242	115006		SCREW, #6-32X1/2", NYLON	
4	241	130021		WASHER, FLAT, PHENOLIC, #4	
4	240	353060		SCREW, #4-40X1/2", SEMS	
4	239	146225		WASHER, FLAT, #4	
4	238	745869		PUSH-RIVIT, PLASTIC	
2	237	658088		SHOULDER SCREW, #8-32X1/4"	
1	236	281196		SCREW, #4-40X3/8", SEMS	
26	235	178533		SCREW, *6-32x1/4", SEMS	
1	234	110536		HEX NUT, #10-32	
1	233	177022		SCREW, *6-32x3/8", SEMS	
2	232	272591		SCREW, #6-32X5/8", SEMS	
9	231	110841		HEX STOP NUT, #5-32	
10	230	298836	8400A-2031	CARD GUIDE	
	229				
	228				

	4	227	508630		INSULATOR, TO-220	
	1	226	306217		INSULATOR, TO-3	
	1	225	342816		SOCKET, TO-3	
	1	224	761809	A21-50-2016	BRKT, FRONT PANEL	
207	1	223	734954	2590A-2016	INSULATOR, MAIN PCB	
		222				
204 N	1	221	723338		I.C., EPROM/OTP 2764	U10
N	1	220	875336		I.C., uP W/PROM SOCKET 97504	U4
	1	219	523639		TRANSISTOR, NPN, 2N5039	Q402
	1	218	508242		DIODE, 25A, 1N6096	CR413
	1	217	631937		LINE FILTER	
207	1	216	722363	A21-50-8014	SHIELD, MAIN P.C.B. ASSY	
	1	215	655456	A21-44-4409	POWER CABLE ASSY	
	1	214	651331	A21-44-2502	HINGE ARM, MODIFIED	
	2	213	464123	2180A-2003	INPUT DRAWER	
	1	212	727925	A21-50-2004	ISOTHERMAL SUPPORT BRACKET	
	1	211	727941	A21-50-2007	FREQUENCY COUNTER SHIELD	
	2	210	727917	A21-50-2003	INTERNAL SUPPORT BRACKET	
	1	209	727958	A21-50-2701	CHASSIS FRAME ASSY	
	1	208	727933	A21-50-2006	POWER SUPPLY SHIELD	
	1	207	734889	A21-50-4008	T/C SELECT ASSY	
	1	206	648675	A21-44-4006	SWITCH DECK #3, ASSY	
	1	205	718627	A21-50-4005	MULTI INPUT SELECT, ASSY	
	1	204	718619	A21-50-4004	SWITCH DECK #1, ASSY	
N	1	203	648642	A21-44-4003	DISPLAY P.C.B., ASSY	
N	2	202	648634	A21-44-4002	T/C INPUT P.C.B., ASSY	
N	1	201	718403	A21-50-4001	MAIN P.C.B. ASSEMBLY	
QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION		REF DES

PARTS LIST

BASIC		
DWG NO. SUFFIX	DRAWING NO	PART NO.
	FIRST USED ON APPLICATION	

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DIMENSIONS IN INCHES

DWN	D.C. BARRETT	5/28/84
CHK	A. Coberly	10-27-6
PROJ ENGR	T.L. ROSE	8/11/84
MFG ENGR	A. K. WIZ/SS	7/4/84
FINISH		

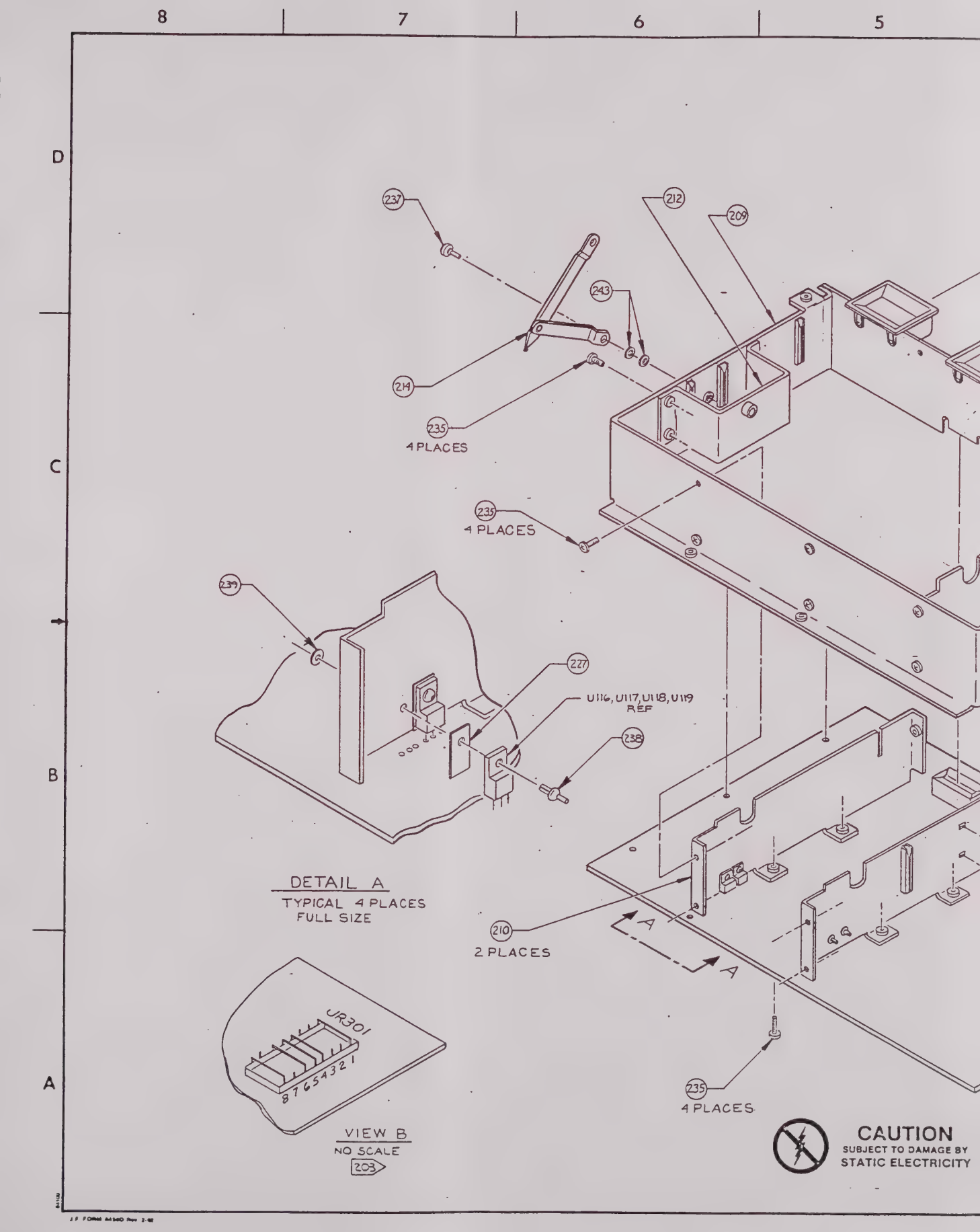
A21-50 TEST & BUTTON UP (GROUP 02)

PART NO.	SIZE	DRAWING NO.
708941	D	A21-50

SCALE — SH 5 OF 9 REV C

PROPRIETARY

DIST

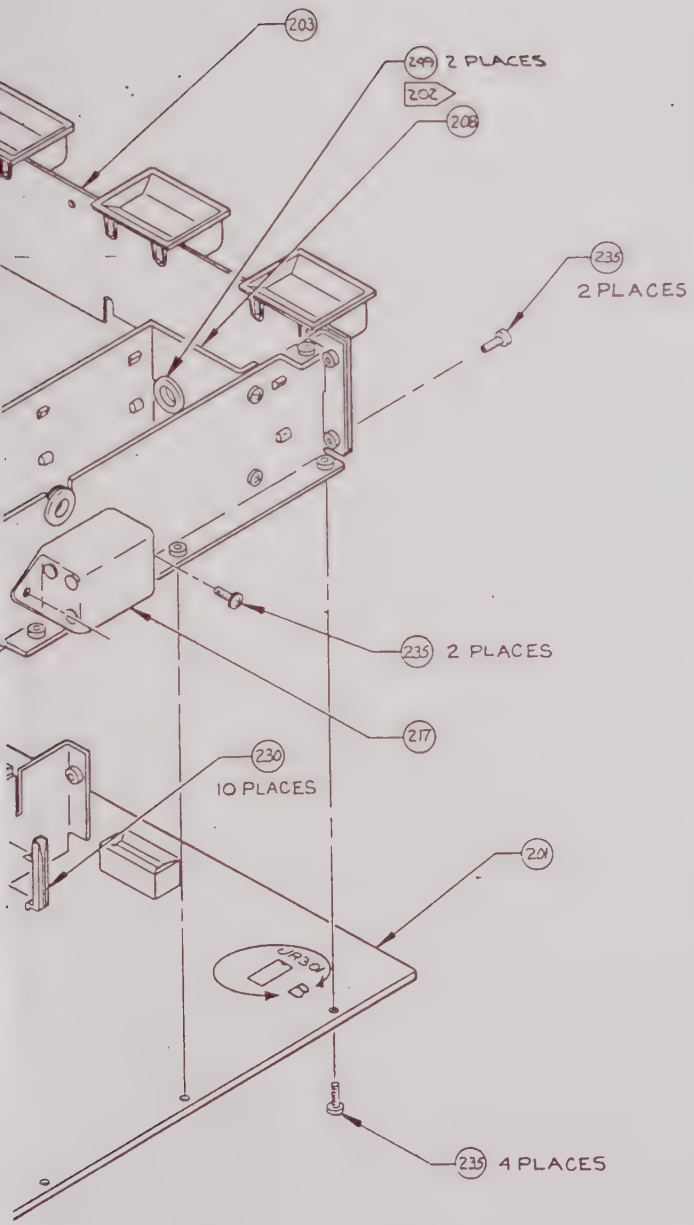

8
7
6
5
D
C
B
A
237
212
209
243
214
235
4 PLACES
235
4 PLACES
239
227
U116, U117, U118, U119
REF
238
DETAIL A
TYPICAL 4 PLACES
FULL SIZE
210
2 PLACES
A
A
UR301
8 7 6 5 4 3 2 1
VIEW B
NO SCALE
203
235
4 PLACES
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

REVISIONS

LTR	DESCRIPTION	EFF	APPROVAL / DATE: DWN	CHK	PROJ ENGR	MFG ENGR

A21-50 SH 6 OF 9 REV C

SEE SHEET 1 FOR REVISIONS



SEE SHEET 5 FOR PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

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BASIC OWG NO. SUFFIX	DRAWING NO	PART NO.
	FIRST USED ON	
	APPLICATION	

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DIMENSIONS IN INCHES: $^{+}_{-}$

FINISH

DWN	B. HANSON	4-27-76
CHK	A Caperly	10-27-76
PROJ ENGR	T.L ROBB	3/1/77
MFG ENGR	A.K WEISS	7/1/87

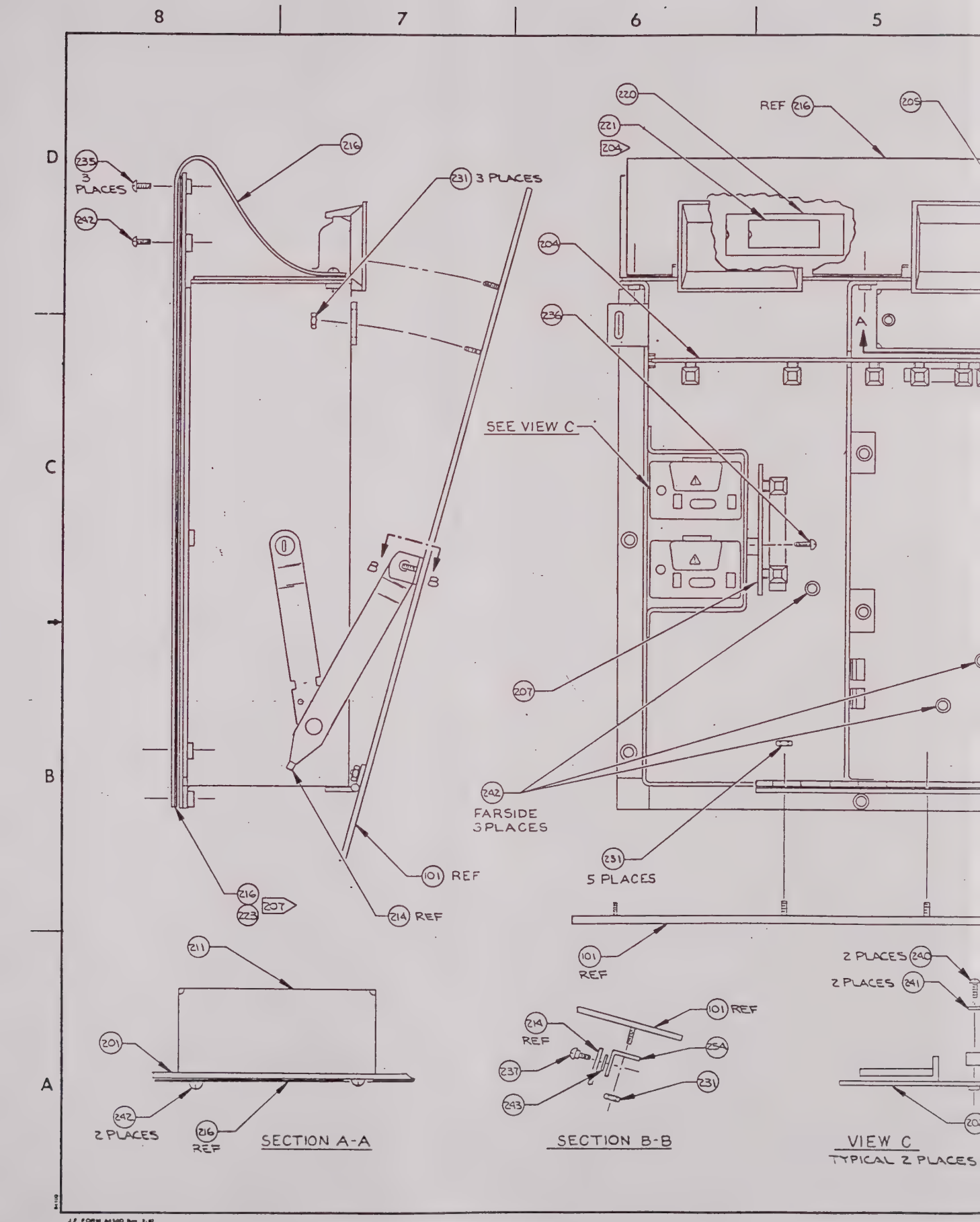
A21-50 TEST & BUTTON UP (GROUP Ø2)

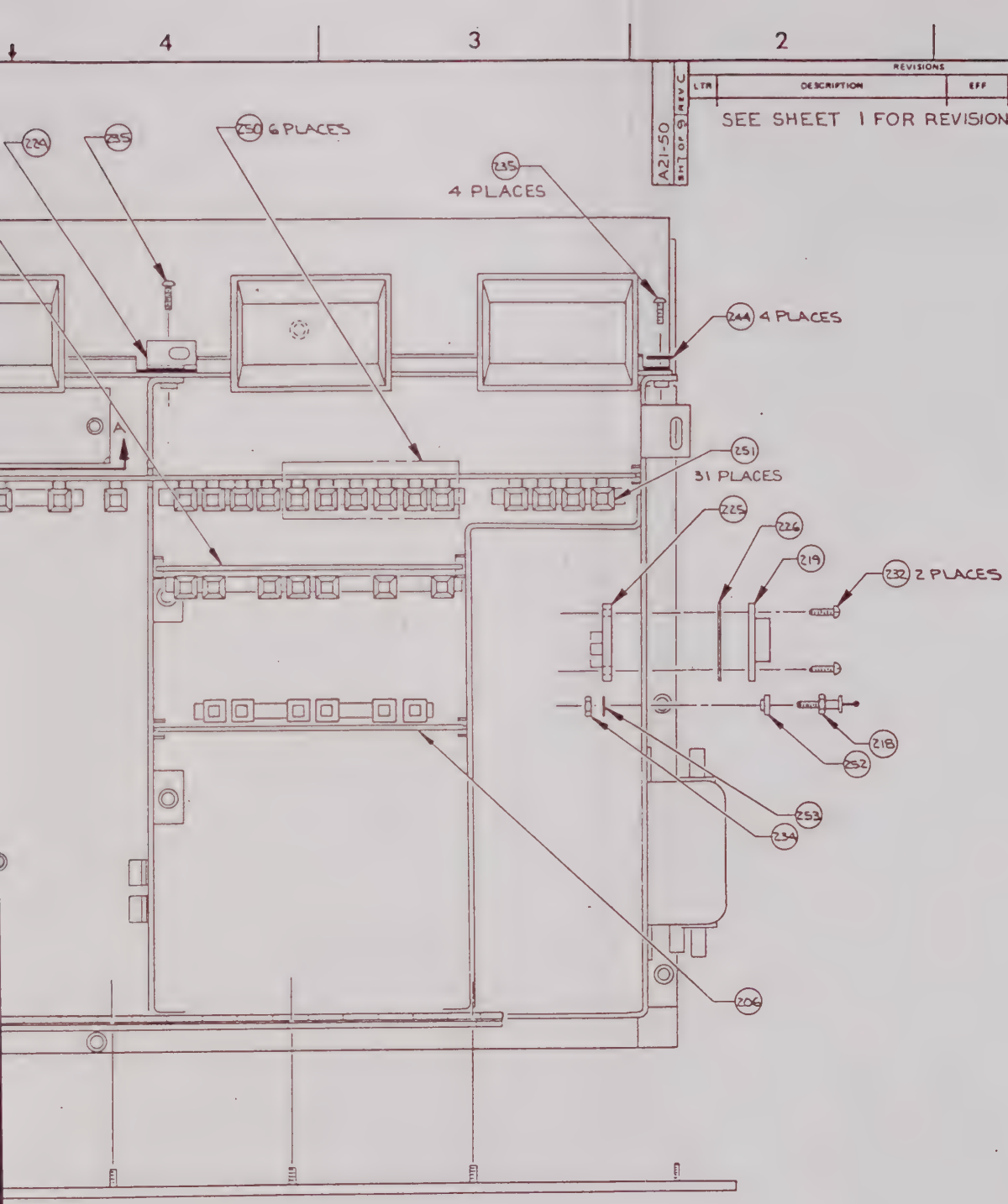
PART NO.	SIZE	DRAWING NO.
708941	D	A21-50

SCALE 1/2 SH 6 OF 9 REV C

PROPRIETARY

DIST


8
7
6
5
D
C
B
A
235
3 PLACES
242
216
231 3 PLACES
B
B
216
207
223
101 REF
214 REF
220
221
204
REF 216
205
204
236
A
SEE VIEW C
207
242
FARSIDE
3 PLACES
231
5 PLACES
101
REF
211
201
242
2 PLACES
216
REF
SECTION A-A
214
REF
101 REF
254
237
231
243
SECTION B-B
2 PLACES 240
2 PLACES 241
VIEW C
TYPICAL 2 PLACES


4
3
2
1
D
B
A
REVISIONS
LTR
DESCRIPTION
EFF
APPROVAL / DATE
DWN
CHK
PROJ ENGR
MFG ENGR
A21-50
SHT OF 9
REV C
SEE SHEET 1 FOR REVISIONS
229
235
250 6 PLACES
235
4 PLACES
244 4 PLACES
A
251
31 PLACES
225
226
219
232 2 PLACES
218
252
253
234
206
213
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY
SEE SHEET 5 FOR PARTS LIST
QTY
ITEM
PART NO.
DRAWING NO
DESCRIPTION
REF DES
PARTS LIST
PROPRIETARY NOTICE
FLUKE
JOHN FLUKE MFG. CO., INC.
P O BOX C9090
EVERETT, WA 98206
89536
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED
TOLERANCE
DIMENSIONS IN INCHES
FINISH
DWN B. HANSON 5-4-84
CHK A Cobb 10-27-84
PROJ ENGR T.L. ROBB 8/1/84
MFG ENGR A.E. WEISS 7/31/84
A21-50 TEST & BUTTON UP
(GROUP Ø2)
PART NO. 708941
SIZE D
DRAWING NO. A21-50
SCALE 1:1
SH 7 OF 9
REV C
BASIC
DWG NO
SUFFIX
DRAWING NO
PART NO.
FIRST USED ON
APPLICATION
PROPRIETARY

8
7
6
5
D
C
B
A
#22 GRN
#22 GRY
#22 BRN
DETAIL IX
#18 BLACK
#18 RED
LOAD
LINE
LINE FILTER
DETAIL VII
CR413 ANODE
SEE DETAIL VIII
SEE DETAIL IX
Q402
LINE FILTER
P29
105
J29
6" #18 RED
6½" #22 GRY
6½" #22 BRN
6½" #22 GRN
12" #18 BLK
9" #18 RED
P24
P23
P22
P21
P19
P20
248
208
P18
P15
P14
P12
P17
P13
P11
P10
P28
P30
P27
CAUTION
SUBJECT TO DAMAGE B
STATIC ELECTRICIT

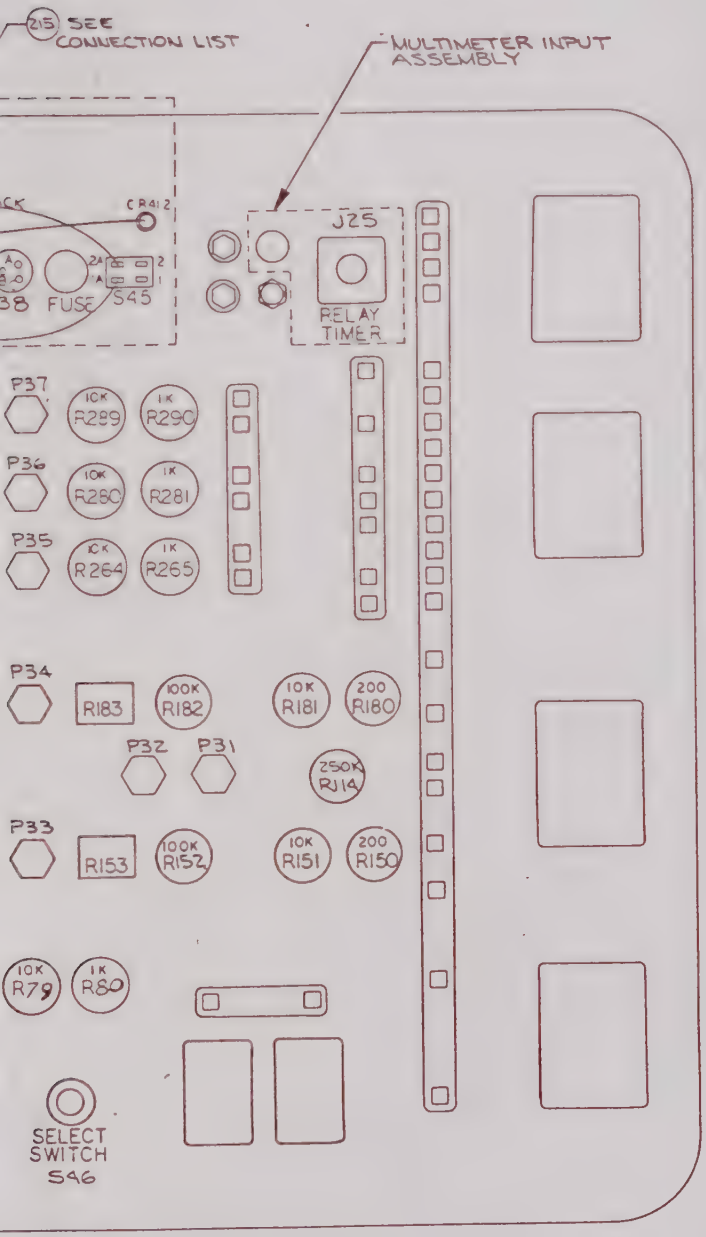
REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR

A21-50 SH 8 OF 9 REV C

SEE SHEET 1 FOR REVISIONS

8 BLACK

8 GRN/YEL
8 RED



ITEM 215 CONNECTION LIST		
WIRE	FROM	TO
#18 GRN/YEL	J38-8	L.F. PIN 4
#18 RED	S45-1A	L.F. PIN 3
#18 BLACK	S45-2A	L.F. PIN 5
#18 RED	P24-1	CR413(CATHODE)
#18 BLACK	P24-2	L.F. PIN 1
#22 RED	P24-3	CR412 (RED)
#18 RED	CR413(ANODE)	L.F. PIN 2

CABLE CONNECTIONS	
FROM	TO
MULTIMETER INPUT ASSY	P22
RELAY TIMER (J25)	P23
Q402	P29
P37, R289 & R290	P21
P36, R280 & R281	P19
P35, R264 & R265	P20
R180, R181 & R183	P17
R114	P30
R182	P28
R150, R151 & R153	P13
R152	P27
P34	P18
P33	P12
P32	P15
P31	P14
R79 & R80	P11
SELECT SWITCH (S46)	P10

SEE SHEET 5 FOR PARTS LIST

QTY	ITEM	PART NO.	DRAWING NO	DESCRIPTION	REF DES

PARTS LIST

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TOLERANCE
XX = ±
.XXX = ±
ANGLES = ±
DIMENSIONS IN INCHES

DWN	B. HANSON	5-4-84
CHK	A. Caberly	10-27-84
PROJ ENGR	T. L. ROCE	8/1/84
MFG ENGR	A. K. WEISS	7/31/84
FINISH		

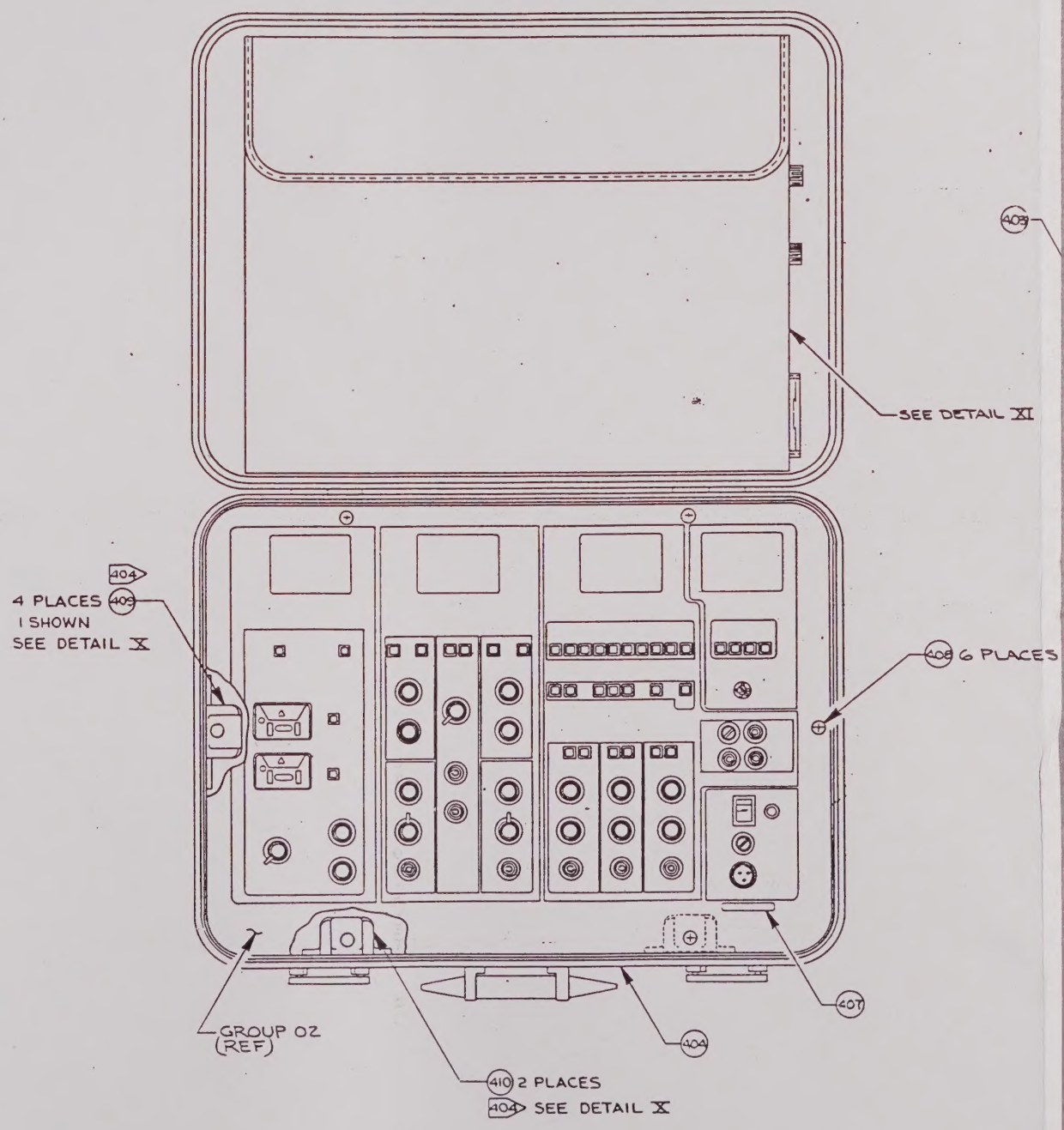
A21-50 TEST & BUTTON UP (GROUP Ø2)

PART NO.	SIZE	DRAWING NO.
708941	D	A21-50

SCALE NONE SH 8 OF 9 REV C

BASIC DWG NO. SUFFIX	DRAWING NO	PART NO
APPLICATION	FIRST USED ON	

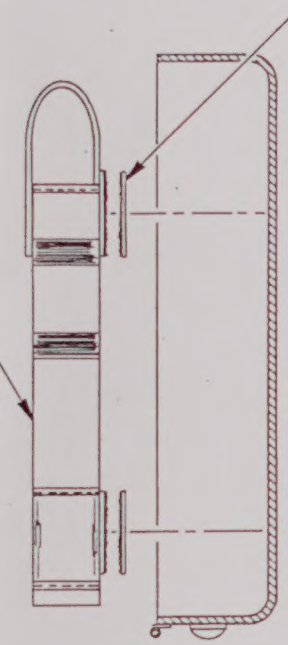
PROPRIETARY


8
7
6
5
D
C
B
A
SEE DETAIL XI
409
4 PLACES
409
I SHOWN
SEE DETAIL X
404
408 6 PLACES
407
GROUP 02
(REF)
410 2 PLACES
404 SEE DETAIL X
404
CAUTION
SUBJECT TO DAMAGE
STATIC ELECTRIC

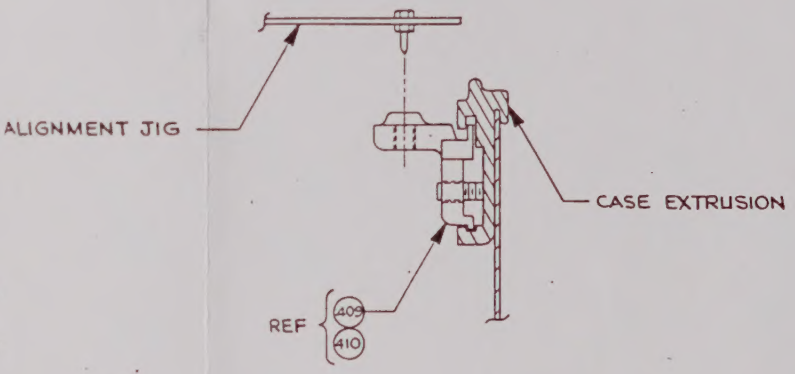
REVISIONS						
LTR	DESCRIPTION	EFF	APPROVAL / DATE			
			DWN	CHK	PROJ ENGR	MFG ENGR

SEE SHEET 1 FOR REVISIONS

A21-50 SH 9 OF 9 REV C



DETAIL XI



DETAIL X
SCALE : NONE
404

NOTES: UNLESS OTHERWISE SPECIFIED

401. TEST PER TEST PROCEDURE A21-50-150.

402. FOR SCHEMATIC DIAGRAM SEE A21-50-1001.

403. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1

404 INSERT PANEL SUPPORT BRACKETS, ITEM-409, AND MODIFIED PANEL SUPPORT BRACKETS, ITEM-410, INTO CASE EXTRUSION AS SHOWN. ALIGN EACH OF THE SIX BRACKETS WITH THE SPIKES ON THE A21-50 ALIGNMENT JIG SO THAT THE SPIKES NOW FIT DOWN THROUGH THE 10-32 THREADED HOLES IN EACH BRACKET. USE AN ALLEN WRENCH TO TIGHTEN THE SET SCREW. DO NOT OVER TIGHTEN. REMOVE THE ALIGNMENT JIG THEN PLACE UNIT INTO THE CASE AND COMPLETE BUTTON-UP.

ITEM 410 IS ONLY USED ON SOME UNITS TO AVOID CONFLICT WITH LATCH HARDWARE. USE QUANTITY SIX OF ITEM 409 WHEN THERE IS NO CONFLICT.

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION	REF DES
2	410	868492	A21-50-2501	MODIFIED PNL SUPPORT BRKT	
4	409	868497	A21-50-8017	PANEL SUPPORT BRACKET	
6	408	740456		SCREW, LT. PEWTER, #10-32	
1	407	472795	M00-800-579	NAMEPLATE, SERIAL NUMBER	
	406				
2	405	722371	A21-50-8016	KEY, CARRYING CASE	
1	404	722801	A21-50-8011	CARRYING CASE, ALUM	
1	403	722439	A21-50-8007	POUCH, VINYL	
2	402	722389	A21-50-8015	VELCRO FASTENER	
	401				

PARTS LIST

BASIC DWG NO.	DRAWING NO	PART NO.
SUFFIX	FIRST USED ON	
APPLICATION		

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ANGLES = ±
DIMENSIONS IN INCHES

DWN	D.C. BARRETT	6/11/84
CHK	A. Cabrera	10-27-84
PROJ ENGR	J. L. ROSS	8/1/84
MFG ENGR	A. K. WEMS	7/31/84
FINISH		

A21-50 TEST & BUTTON UP (GROUP 04)

PART NO.	SIZE	DRAWING NO.
708941	D	A21-50
SCALE —	SH 9 OF 9	REV C

PROPRIETARY

DIST